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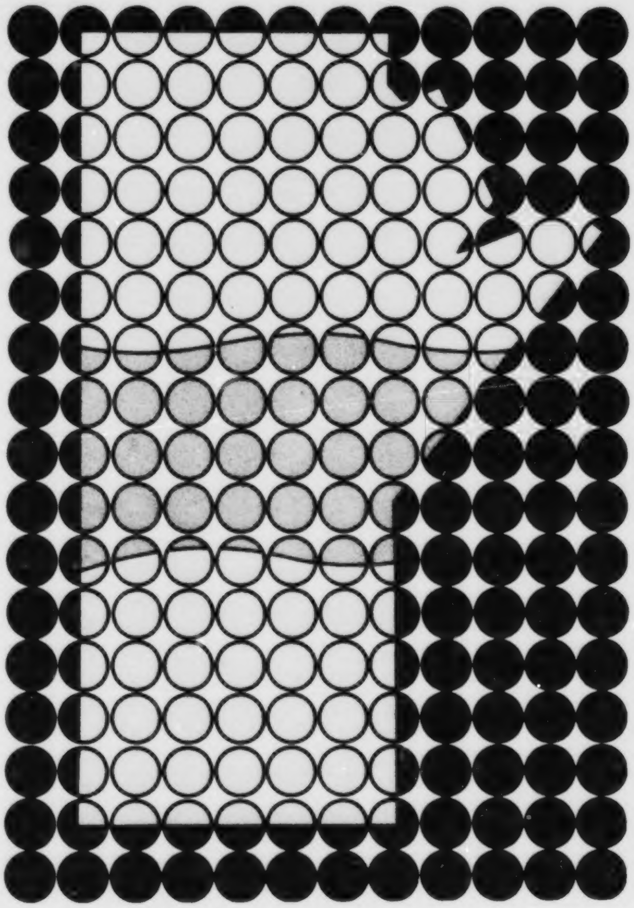

CANADA — MANITOBA
Soil Survey

Soils of the Shellmouth Reservoir-North Area

Report D63

Government of Canada
Gouvernement du Canada

Government of Manitoba
Gouvernement du Manitoba

MG 6593-D57

SOILS REPORT No. D63 1986

SOILS OF THE SHELLMOUTH RESERVOIR-NORTH AREA

WITH

INTERPRETATIONS FOR AGRICULTURE, ENGINEERING and RECREATIONAL LAND USE

by

W. MICHALYNA
and
W.R. FRASER

CANADA-MANITOBA SOIL SURVEY

AGRICULTURE CANADA

MANITOBA DEPARTMENT OF AGRICULTURE

DEPARTMENT OF SOIL SCIENCE, UNIVERSITY OF MANITOBA

PREFACE

This interim report and map of the detailed field and laboratory study of the soils of the Shellmouth Reservoir North area is one in a new series of such soil survey reports covering special interest areas in southern Manitoba. These reports reflect the growing concern by various government agencies that support the Canada-Manitoba Soil Survey, that a knowledge of the development and distribution of the soils of Manitoba is the key to understanding their properties, behavior and response to management. This concern requires that soils be described both in terms of their basic properties and the nature of the environmental setting in which they are found. Thus, when these areas require delineation of land of high or low value for crop production or for other uses, the basic reference document is an accurate and reliable soil map.

The land resource information included in this resurvey covers approximately 4 650 ha of land. It covers only a fraction of the area covered in the former reconnaissance surveys of Grandview areas (Report No. 9). However, the projected more intensive use of the soils for recreation, agriculture and the growing competition for other uses of land in the areas has created a need for more up-to-date, more accurate and more detailed soil information. The increased examination of soils in the field, the use of current aerial photography, the use of improved methods of studying soils in the laboratory and the accumulated knowledge of the properties and uses of soils over the years, have all contributed to the additional information contained in this new series of reports and maps.

During the course of the resurvey of the map areas, a large volume of site specific soil data was generated that for practical reasons cannot be included in this interim report. These data are currently being input into the Canada Soil Information System (CanSIS) data bank. This computerized system of data management permits automated manipulation and statistical evaluation of large volumes of data for soil characterization and interpretations. These data will shortly be available on request. In addition, the cartographic file of CanSIS provides a capability to produce derived maps of various kinds quickly and inexpensively. The types of derived maps that can be generated from the basic soil map include the sixteen interpretations that are provided in tabular form in this report as well as a number of single feature maps for such characteristics as drainage, texture of surface deposits, slope, stoniness and distribution of salinity. A package of interpretive maps and single feature derivative maps can be made available on request to: The Canada-Manitoba Soil Survey, Dept. of Soil Science, Rm. 362, Ellis Bldg., University of Manitoba, Winnipeg R3T 2N2.

The Canada-Manitoba Soil Survey trusts that this report and accompanying map will be of value to all individuals and agencies involved with the use of land within the map area.

R.E. Smith

Director

Canada-Manitoba Soil Survey

ACKNOWLEDGEMENTS

This soils study was conducted as a joint project of the Canada Department of Agriculture, Manitoba Department of Agriculture and the Soil Science Department of the University of Manitoba.

The soils were mapped by W. Michalyna.

The field assistants were J. Johnson, D. Swidinsky.

Laboratory analysis were provided by R. Mirza, K.C. Yeung and J. Madden under the direction of P. Haluschak.

Cartographic Services -

Mapping bases provided by the Land Resource Research Institute, Ottawa.

Map compilation and digitization in preparation for publication and addition to the CanSIS cartographic file by J. Griffiths, R. DePape and M. Brown

Manuscript review and soil correlation were provided by R.E. Smith and W. Fraser.

Final inputting of the report manuscript provided by Barbara Stupak.

Mr. Al Kohuska, Geotechnical Engineer, Manitoba Natural Resources Branch for discussion and sharing his experiences on slide problems along the Upper Assiniboine Valley.

HOW TO USE THIS SOILS REPORT

This soils report contains considerable information about the soils, their origin and formation, their classification and their potential for various uses such as dryland agriculture, irrigation, engineering and recreation. The report is divided into four parts:

Part 1	provides a general description of the area;
Part 2	describes the methodology used in the study;
Part 3	discusses the development, scientific classification and morphological characteristics of the soils in the study area;
Part 4	provides an interpretation of soil properties and associated landscape features as they affect soil capability or suitability for various uses.

The soil map of the study area is compiled on an uncontrolled air photo base which is included in a pocket of the report folder. The map shows the distribution of soil types and associated landscape features that are significant for potential use as field management units. It provides a linkage from landscapes within the study area to the information contained in the report.

To assist the user in retrieving soil information quickly, the following steps are suggested:

If project consists of many individual maps, proceed with STEP 1; if only single map in pocket, proceed with STEP 2 to 6.

STEP 1 Consult the index to map sheets if the report contains many maps. Locate the areas of interest and note the map sheet number(s) which identify the township and range on each map.

STEP 2 Consult the soil map in pocket of report folder. Locate the area(s) of interest on the map and identify the pertinent map unit symbols. Arabic numerals placed as superscripts following map symbols indicate the approximate proportion of each soil type within the map unit.

STEP 3 Consult the extended legend accompanying the soil map for an alphabetical listing of soil symbols giving the soil name, classification, drainage and related information concerning landforms, nature and depth of materials, and dominant vegetation.

STEP 4 For interpretive information about the soils, consult the appropriate Table in Part 4. Criteria utilized as guidelines in making these interpretations are provided in the Appendix.

STEP 5 Further information concerning the morphological properties and extent of the soils is presented in Part 3 where the soils are described alphabetically according to soil name.

STEP 6 Additional site-specific information not contained in this report is available on request from the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba.

TABLE 1

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Detailed Studies and Surveys								
D1	Pasquia (No. 11)	Pub. 1960	57 200	a,b,d	3	1:63,360	Color	A
D2	Glenlea Research Station	Int. 1963	541	a,b	1	1:7,920	Photo	A
D3	Morden Experimental Farm	Int. 1961	256	a,b	1	1:12,000	Photo	A
D4	Onanole	Int. 1968	768	a,b	1	1:7,920	Photo	U
D5	York Factory Area	Int. 1969	768	a	3	1:63,360	B&W	
D6	McCreary Tile Drain Project	Int. 1971	64	a,b	1	1:5,000	B&W	A
D7	Brandon Experimental Farm	Int. 1985	768	a,b	1	1:7,920	Photo	A
D8	Portage Potato Farm	Int. 1972	480	a,b	1	1:4,800	Photo	A
D9	Portage la Prairie (No. 17)	Pub. 1972	113 200	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D10	Morden-Winkler (No. 18)	Pub. 1973	71 424	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D11	Deep Lake	Int. 1975	1 400	a,b	1	1:6,000	B&W	R
D12	Thompson Environmental Study	Int. 1976	32	a,b	1	1:1,000	B&W	
D13	Organic Soil Study of Alexander L.G.D.	Int. 1975	29 456	a,b	3	1:63,360	B&W	A
D14	Winnipeg Region	Pub. 1975	280 000	a,b,c	2	1:20,000	Photo	A,E,U,R
D15	Brandon Region	Pub. 1976	59 600	a,b,c	2	1:20,000	Photo	A,E,U,R
D16	Boissevain-Melita (No. 20)	Pub. 1978	262 912	a,b,c	2	1:20,000	Photo	A,I,E,U,R
D17	Carman	Pre.	73 905	a,b	2	1:20,000	B&W	A,E,R
D18	Orr Lake	Int. 1977	20	a,b	1	1:1,000	B&W	
D19	Pelican-Rock Lake	Int. 1983	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D20	West Portage	Int. 1982	120 956	a,b	2	1:20,000	Photo	A,I,E,R
D21	Minnewasta	Int. 1978	2 560	a,b	2	1:20,000	Photo	A,E,R,I
D22	Killarney	Int. 1979	4 600	a,b	2	1:20,000	Photo	A,E,R,I
D23	Matlock-Gimli-Riverton	Int. 1981	18 400	a,b	2	1:20,000	Photo	A,E,R,I
D24	Glenboro	Int. 1979	5 960	a,b	2	1:20,000	Photo	A,E,R,I
D25	Sandy Lake	Int. 1980	1 720	a,b	2	1:20,000	Photo	A,E,R,I
D26	Brokenhead	Int. 1979	10 813	a,b	2	1:20,000	Photo	A,E,R,I,U
D27	Rockwood	Int. 1980	12 928	a,b	2	1:20,000	Photo	A,E,R,I,U
D28	Oak Lake	Int. 1979	1 293	a,b	2	1:20,000	Photo	A,I
D29	Bird River	Int. 1980	2 560	a,b	2	1:20,000	Photo	A,E,R
D30	North Shore Lac du Bonnet	Int. 1980	2 400	a,b	2	1:20,000	Photo	A,E,R
D31	Grindstone Point	Int. 1979	8 040	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report Status[1]	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
D32	Paint Lake	Int. 1980	2 880	a,b	2	1:10,000	Photo	A,E,R
D33	Cranberry Portage	Int. 1980	80	a,b	1	1:5,000	Photo	A,E,R
D34	Dauphin	Int. 1981	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D35	South Riding Mtn.	Pre.	23 488	a,b	2	1:20,000	Photo	A,E,R
D36	West Interlake	Int. 1981	10 036	a,b	2	1:20,000	Photo	A,E,I,R
D37	Swan R. Townsite	Pre.	7 680	a,b	2	1:20,000	Photo	A,E,R,I
D38	Hadashville-organic	Int. 1981	6 475	a,b	3	1:40,000	Photo	A,E,I,R
D39	Part of L.G.D. Stuartburn (Rat River)	Pre.	27 972	a,b	3	1:40,000	Photo	A,E,I,R
D40	Falcon L-Brereton L	Pre.	25 900	a,b	2	1:20,000	Photo	A,E,R
D41	Quesnel Lake-North Shore Winnipeg River	Pre.	3 000	a,b	2	1:20,000	Photo	A,E,R
D42	Duck Mountain	Int. 1982	3 036	a,b	2	1:20,000	Photo	A,E,R
D43	Spruce Woods	Pre.	26 300	e	3	1:40,000	Photo	A,E,R
D44	McGregor	Int. 1982	3 910	a,b	2	1:20,000	Photo	A,E,R
D45	Pine Creek	Int. 1983	1 942	a,b	2	1:20,000	Photo	A,E,R,I
D46	Arborg-Riverton	Int. 1982	2 590	a,b	2	1:20,000	Photo	A,E,R,I
D47	Roblin	Int. 1983	4 096	a,b	2	1:20,000	Photo	A,E,R,I
D48	Flin Flon	Pre.	4 600	a,b	2	1:20,000	Photo	A,E,R
D49	St. Anne-La Broquerie	Pre.	74 592	a,b	3	1:40,000	Photo	A,E,R,I
			4 662	a,b	2	1:20,000	Photo	A,E,R,I
D50	City of Brandon	Int. 1984	2 980	a,b	2	1:20,000	Photo	A,E,R,I
D51	Westbourne	Int. 1985	51,456	a,b	2	1:20,000	Photo	A,E,R,I
D52	Notre Dame, Rathwell, Treherne Townsites	Int. 1984	6 144	a,b	2	1:20,000	Photo	A,E,R,I
D53	Altona, Emerson, Gretna, Ile des Chenes, Landmark, Letellier, Rosenort, St. Jean Townsites	Int. 1984	14 080	a,b	2	1:20,000	Photo	A,E,R,I
D54	Russell, Binscarth-Townsites	Int. 1984	3 584	a,b	2	1:20,000	Photo	A,E,R,I
D55	St. Rose Du Lac-Townsite	Int. 1985	1 536	a,b	2	1:20,000	Photo	A,E,R,I
D56	Souris, Wawanesa, Virden, Townsites	Int. 1986	6 400	a,b	2	1:20,000	Photo	A,E,R,I
D57	Fraserwood, Inwood, Komarno Townsites, Lake Man. Shoreline	Pre.	1 856	a,b	2	1:20,000	Photo	A,E,R,I
D58	Hallboro, Minnedosa-Townsites	Int. 1984	4 544	a,b	2	1:20,000	Photo	A,E,R,I
D59	Beaudry Park	Data	640	a,b	2	1:20,000	Photo	A,E,R
D60	Portions of Dufferin, Grey, and Roland	Data	68 488	a,b	2	1:20,000	Photo	A,E,R,I
D61	Meditation Lake	Data	3 072	a,b	2	1:20,000	Photo	A,E,R
D62	Wanipigow Lake	Data	8 960	a,b	2	1:20,000	Photo	A,E,R

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report Status[1]	Area in Hectares	Map Unit Description[2]	Survey Intensity Level[3]	Map Scale	Map Base[4]	Land Evaluation & Interpretations[5]
D63	Shellmouth Resevoir-N	Data	4 650	a,b	2	1:20,000	Photo	A,E,R,I
D64	Assiniboine River	Pre.	4 095	a,b	2	1:20,000	Photo	A,E,R,I
D65	Villages of Hamiota, Strathclair, Rapid City, Newdale, Birtle, Shoal Lake	Pre.	5 180	a,b	2	1:20,000	Photo	A,E,R,I
D66	Springfield R.M.	Pre.	13 440	a,b	2	1:20,000	Photo	A,E,R,I
D67	St. Eustache, Springstein, Perimeter Strip, Brunkild, La Salle R.	Pre.	6 200	a,b	2	1:20,000	Photo	A,E,R,I
D68	Spruce Point Mine Area	Pub.	450	a,b	2	1:10,000	Photo	E,R
D69	Snow Lake	Data						
Reconnaissance Surveys								
R1	South Western (No. 3)	Pub. 1940	709 600	d	3	1:125,000	B&W	A
R2	South Central (No. 4)	Pub. 1943	967 600	d	3	1:125,000	B&W	A
R3	Winnipeg and Morris (No. 5)	Pub. 1953	1 419 200	d	3	1:125,000	Color	A
R4	Rossburn and Virden (No. 6)	Pub. 1956	1 372 400	d	3	1:125,000	Color	A
R5	Carberry (No. 7)	Pub. 1957	967 600	d	3	1:125,000	Color	A
R6	West-Lake (No. 8)	Pub. 1958	592 800	d	3	1:125,000	Color	A
R7	Grandview (No. 9)	Pub. 1957	689 200	d	3	1:125,000	Color	A
R8	Nelson River Basin (No. 10)	Pub. 1973	224 000	b	3	1:100,000	Color	A
R9	Fisher and Teulon (No. 12)	Pub. 1961	949 200	a,c	3	1:100,000	Color	A
R10	Swan River (No. 13)	Pub. 1962	316 000	a,c	3	1:125,000	Color	A
R11	South Eastern (No. 14)	Pub. 1964	749 200	a,c	3	1:125,000	Color	A,F
R12	Lac du Bonnet (No. 15)	Pub. 1967	764 800	a,c	3	1:125,000	Color	A,F,R
R13	Grahamdale (No. 16)	Pub. 1971	764 800	a,b	3	1:125,000	Color	A,F,U,R,E
R14	Red Rose-Washow Bay (No. 19)	Pub. 1975	704 400	a,b	3	1:125,000	Color	A,F
R15	Boissevain-Melita (No. 20)	Pub. 1978	299 520	a,b	2	1:40,000	Photo	A,I,E
R16	Ste. Rose (No. 21)	Pub. 1981	676 705	a,b	3	1:125,000	Color	A,I,R,E,F
R17	Waterhen (No. 23)	Pub. 1985	949 600	a,b	4	1:125,000	B&W	A,I,R,E,F
R18	Swan Lake	Data	599 200	a,b	3,4	1:125,000	B&W	A
R19	The Pas (No. 22)	Pub. 1982	791 700	a,b	4	1:125,000	Color	A,I,E,R,F
R20	Grand Rapids	Pre.	675 031	a,b	4	1:125,000	B&W	A
R21	Cormorant	Int. 1975	920 000	a,b	4	1:125,000	B&W	A
R22	Wekusko	Pre.	1 400 000	a,b	4	1:125,000	B&W	A
R23	Pointe du Bois	Data	740 000	a,b				
R24	Roseau River	Pub. 1977	45 200	a,b	3	1:63,360	B&W	A
R25	Red Deer Lake	Pub. 1966	34 860	a,b	2	1:31,680	Photo	A
R26	Cross Lake and Norway House	Pre.	615 200	a,b	4	1:125,000	B&W	A
R27	South Central - Escarpment	Pre.	107 744	a,b	2,3	1:40,000	Photo	A,E,R
R28	Pasquia Lake	Pub. 1984	2 330	a,b	3	1:50,000	B&W	A,E
R29	Lorne R.M.	Pre.	512	a,b	2	1:20,000	Photo	A,E,R,I
			4 608	a,b	2	1:20,000	Photo	A,E,R,I
			73 728	a,b	3	1:50,000	N.T.S.	A,E,R,I

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report Status[1]	Area in Hectares	Map Unit Description[2]	Survey Intensity Level[3]	Map Scale	Map Base[4]	Land Evaluation & Interpretations[5]
R30	Benito	Pre.	18 432	a,b	3	1:50,000	Photo	A,E,R,I
R31	R.M. Woodlands	Pre.	9 980	a,b	3	1:50,000	Photo	A,E,R,I
R32	Whitemouth Peatland		10 240	a,b	3	1:50,000		
R33	R.M. Rockwood					1:125,000		
R34	R.M. South Norfolk	Pre.	7 936	a,b	3	1:50,000	N.T.S.	A,E,R,I
			2 304	a,b	2	1:20,000	Photo	A,E,R,I

SUMMARY OF SOIL SURVEY COVERAGE FOR MANITOBA (continued)
JANUARY, 1986

Map Project Designation	Name (Soil Report No.)	Report[1] Status	Area in Hectares	Map Unit[2] Description	Survey[3] Intensity Level	Map Scale	Map[4] Base	Land Evaluation[5] & Interpretations
Biophysical and Exploratory Surveys								
B1	Lake Winnipeg, Churchill & Nelson Rivers	Pub. 1973	3 600 000	e	4	1:250,000 1:50,000	B&W	
B2	Churchill Transportation Corridor	Data 1974	179 000	f	4	1:125,000	B&W	
B3	54C Hayes River	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B4	54D Kettle Rapids	Int. 1976	1 370 300	f	4	1:125,000	B&W	
B5	52M Carrol Lake	Int. 1977	634 000	f	4	1:125,000	B&W	
B5	62P Hecla	Int. 1977	466 200	f	4	1:125,000	B&W	
B6	53D Deer Lake	I						
						1:125,000	B&W	
B8	63H Norway House	Data	540 800	f	4	1:125,000	B&W	
B9	SE 1/4 64A Split Lake	Int. 1979	342 400	f	4	1:125,000	B&W	
B9	63P Sipiwesk	Int. 1979	1 405 900	f	4	1:125,000	B&W	
B10	53E Island Lake	Pre.	1 286 900	f	4	1:125,000	B&W	
B11	63H Norway House	Data				1:125,000	MSS	
E1	Surface Deposits & Soils of Northern Manitoba	Int. 1963		g	5	1:1,267,000	B&W	
E2	Exploratory Terrain Study of Northern Manitoba and Southern Keewatin, N.W.T.	Int. 1974		g	5	1:1,000,000	B&W	

1. Report Status
   Pub.-Published Report and Map
   Int.-Interim Report and Map Available
   Pre.-Preliminary Map and Legend Available
   Data-Field Data Available Only

2. Map Unit Descriptions Code
   a-single series and phases
   b-series complexes defined as to proportion
   c-series complexes undefined as to proportion
   d-associations
   e-biophysical units (materials and physiography)
   f-biophysical units (associations & complexes of associations)
   g-regional and local physiographic units

3.Survey Intensity Levels

Code	Name	Scale	Minimum Size Delineation(ha)	Inspection Density (Approx. range)
1	Very detailed	>1:12,000	<1.5	[illegible] per 3 ha
2	Detailed	1:12,000 to 1:40,000	1.5-16	1 per 3 to 50 ha
3	Semi-detailed	1:40,000 to 1:125,000	16 to 256	1 per 10 to 1 000 ha
4	Reconnaissance	1:125,000 to 1:250,000	256 to 625	1 per 100 to 110 000 ha
5	Exploratory	1:250,000 to 1:1,000,000	625 to 110 000	1 per 300 to 500 000 ha

4.Published Map Base Code

Photo	Photomosaic
B&W	Black and white line
Color	Colored line

5.Interpretations Code

A	Agriculture Capability
E	Engineering
F	Forestry
I	Irrigation Suitability
U	Urban Planning and Community Development
R	Recreation

TOTAL HECTARAGE COVERED

	1985	To Date
Initial Reconnaissance	---	18,619,436
Initial Detailed survey	1,554	18,014
Detailed Resurvey	123,029	1,970,192
Biophysical Survey	---	12,521,000

Published Reports, Maps, Interim Reports, available at a cost of $2.00 per copy (except for D20) from:

Queen's Printer,
Publications Branch,
Manitoba Archives Bldg.,
200 Vaughan St.,
Winnipeg, Manitoba R3C 1T5
Phone:945-3103

Detailed Surveys of Winnipeg Region and Brandon Region available at a cost of $6.00 each from:

Municipal Planning Branch
Manitoba Dept. of Municipal Affairs
1418-405 Broadway Ave.,
Winnipeg, Man., R3C 3L6
Phone: 945-2150

Biophysical Land Classification Maps and Reports available at a cost of $3.50 each from:

Surveys and Mapping Branch
Century Industrial Branch
989 Century Plaza
Winnipeg, Man., R3H 0W4
Phone: 945-6666

Preliminary Map and other field data available from:

Canada-Manitoba Soil Survey Office,
Rm. 362 Ellis Bldg., University of Manitoba
Winnipeg, Man., R3T 2N2
Phone: 474-6115 or 474-6118

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PART 1

GENERAL DESCRIPTION OF THE STUDY AREA

1.1 LOCATION AND EXTENT

The Shellmouth Reservoir-North Study area is located along the Assiniboine River in Shell River Municipality in Townships 25 and 26, Range 29W (Figure 1). The study covers 14.25 sections (6 280 ha) with a land area of approximately 4 650 ha; the map provides more detailed information at a scale of 1:20,000 for a small portion of the area reported in the Reconnaissance Soil Survey of the Grandview Area (Ehrlich et al. 1959). Soil Survey coverage for other areas in Manitoba is presented in Table 1 of this report.

The area may be accessed from Highways 5 and 83, and PTH 482. Larger centers include the Town of Roblin (approximately 12 km to the east) with a population of 2190 and the Town of Russell (approximately 40 km to the south) with a population of 2025.

1.2 SHELLMOUTH RESERVOIR

The Shellmouth Reservoir has been operative since 1969-70 (McKay et al. 1969). It has an earth-fill construction and a reinforced concrete chute spillway with a fixed crest elevation of 430 m.a.s.l. (1 410 ft.). The level of the impounded water would fluctuate from the level of 430 m to a summer level of approximately 428 m (1 404 ft.); in dry years, the level could be appreciably lower.

During the fall and winter, the level of reservoir is lowered to allow space for the impending spring buildup of water. The lowest annual levels are expected to be about 424 m (1 390 ft.).

The impoundment will be contained within the natural confines of the Assiniboine and Shell Valleys. The shoreline area was cleared of trees and shrubs, and various man-made structures to an elevation of 430.4 m (1 412 ft.).

1.3 LAND USE

The land use of the area is mainly agriculture and recreation. Since the completion of the reservoir, the Lake of the Prairies Provincial Park has provided an increased opportunity for sports fishing, camping, hiking, and cottaging. To date, only a few locations have been developed to facilitate trailer parking, camping and launching sites; these are at Pyotts Point and two on either side of the bridge on Hwy. 5. Limited cottage development has occurred on private property, mainly in sections 4 and 9 in 25-29W, and 5-26-29W.

Most of the land along and within the valley is held as Crown land (McKay et al. 1969). Grazing permits have been provided for a considerable portion of these lands to farmers who own and cultivate the adjacent upland areas.

The dominant agriculture in the area is mixed farming including cereal grain and livestock production.

Most of the land within the valley has considerable tracts of native vegetation which provide some stability for the steeper slopes and provide very good habitat for deer as well.

1.4 PHYSIOGRAPHY

The Shellmouth Reservoir North study area occurs in the northern portion of the Newdale Plain subsection of the Assiniboine River Plain in Manitoba (Figure 2). This area is characterized by hummocky morainal landforms with numerous permanent lakes and wetlands. The Assiniboine River Valley dissects the Newdale Plain. Within the study area, the morainal plain is relatively level with low relief and sloping gently to the valley edge which occurs at approximately 495 m.a.s.l. on the west and 510 m on the east. The valley width varies from 1.6 to 2.5 km. The upper slopes of the valley are relatively steep; the intermediate and lower slopes are less steep and have hummocky to ridged features that have resulted from previous mass wasting. The lake level is approximately 430 m.a.s.l.

1.5 BEDROCK

The underlying bedrock (Figure 3) consists of Cretaceous shales of the Riding Mountain Formation, Millwood Member (Manitoba Minerals Resources Div., 1979-2). Klassen (1975) reported that Cretaceous shale was exposed along the lower slopes and terraces of the Assiniboine valley in proximity of Boggy Creek and its estimated elevation is above the former flood plain at approximately 427 to 465 m.a.s.l. It was also reported that slumps were common along the lower slopes.

In this study, soils on high swelling clays were observed from lake level (432 m) to approximately the 457 m contour along the Assiniboine Valley in Shell River Municipality. It was considered that these soils formed in situ within the Millwood member of the Riding Mountain Formation. Soluble salts, gypsum, yellowish compounds (jarosite) and a few calcite nodules were noted below the solum; large oblong brown ironstones (up to 30 cm dia.) were common within these soils.

The Millwood member is characterized as soft greenish brown bentonitic shales (Bannatyne 1970). They are composed dominantly of high swelling montmorillonite clay minerals and contain large brown to reddish brown ironstones. In some strata, small yellowish calcite limestone concretions are common. These shales contain considerably more sodium than other members of the Riding Mountain Formation.

In the upland area, the depth to bedrock varies from 45 m on the west and northeast of the area to 125 m in the southeast part.

1.6 SURFACE DEPOSITS

The surface deposits consist dominantly of loam textured, hummocky morainal till derived from Cretaceous shales, Paleozoic dolomitic limestone and granitic rocks of the Precambrian Era, with minor areas of glaciolacustrine veneers and glaciofluvial deposits (Figure 4).

Surface deposits are complex within the study area due to sequence of ice retreat, localized laking, and surface modification by glacial fluvial waters. Within the valley, downcutting of the Assiniboine River channel has resulted in considerable slumping of the valley walls.

Cross-sections perpendicular to the valley (Figure 5) indicate the dominant near surface deposits of morainal till with underlying strata of sand and gravel, silt and clay, and till of a previous glaciation. Slumps along the valley wall include any one or a combination of these strata.

Valley walls are comprised of colluvium and slump debris (Klassen 1975); these materials appear morainic and commonly can be identified with the regional till (see Appendix F). In areas adjacent to sandy or gravelly upland deposits, a mixture of till and gravelly sands are common.

Along the lower slopes, generally below 457 m, heavy clay materials are common and appear to be veneers of till-like material or a mixture of clayey till, and sandy material that could have moved downslope through slumping.

1.7 RELIEF

The elevation within the study area varies from 430 m (lake level) to 518 m.a.s.l. in the northeastern part (Figure 6). The upland areas adjacent to the valley at elevations of 495 m.a.s.l. on the west and 510 m.a.s.l. on the east, have nearly level to very gentle slopes of less than 0.5 percent. The valley walls are generally steep with slopes commonly varying from 40 to 85 percent, depending on whether or not the valley edge has been subjected to mass wasting processes. Generally, land areas below the 440 to 460 m.a.s.l. level are not as steep with slopes commonly ranging from 6 to 15 percent. These hummocky to ridged landscapes appear to be land slumps having a sawtooth pattern and often continue to the water edge. Water impoundment and seepage are common behind the larger slump ridges.

Many small intermittent drainageways from the uplands dissect the valley walls to form ravines with slopes of 35 to 75 percent. At the lower parts of the valley, these drainageways wind their way between the slump ridges and often appear as seepage areas along the present lakeshore.

1.8 SURFACE AND SUBSURFACE HYDROLOGY

Surface drainage in the uplands is poorly developed as most of the precipitation either enters the soil directly or flows laterally into nearby depressions (Figure 6). During periods of heavy rainfall, overflow from the depressions follows poorly developed intermittent drainageways toward the Assiniboine River. Water in depressions moves slowly downward to recharge the groundwater. On the coarser sandy and gravelly deposits on the eastern side of the valley, water enters the rapidly permeable materials to the groundwater.

Along the valley walls, drainage can be considered as poorly developed; good drainage occurs near the intermittent drainageways that flow from uplands; between these intermittent waterways, drainage is slow or impeded behind the sequence of sawtooth slump ridges (see Appendix F). The wet conditions may also be due to ponding of seepage or flowing springs. Only the larger areas of impeded drainage have been identified on the soil map. Most of these wet areas are level, but some may occur along steeper slopes from which seepage waters emerge.

1.9 CLIMATE

The climate of the area is designated as Cryoboreal, moderately cold, subhumid continental (Canada Dept. of Agriculture 1972). The mean annual temperature is estimated to be between 0.7 and 1.2 degrees C (based on climatic data for Russell and Yorkton, respectively) and the mean annual precipitation between 434 and 451 mm (Table 2). The mean frost free period is 102 days (Russell); one out of ten years, the frost free period could be less than 77 days.

1.10 VEGETATION

The study area lies within the aspen-oak section of the Boreal Forest Region of Canada (Rowe 1959). The native vegetation is dominantly mixed deciduous. Trembling aspen is the most prevalent species and generally occurs along the valleys and upland adjacent to the valley. Areas of mixed aspen and grassland occur in the southwest portion of the study area. Steeper slopes with southern and southwest exposure along the valley sidewalls commonly support grass vegetation with only scattered distribution of oak and aspen. On the coarser sandy and gravelly soils, mixed aspen, oak and grassland are common. Other tree species in the area include Balsam poplar in moist positions, and some white spruce in the northeastern part of the area. Willows are common around the margin of the wet depressional areas with sedge and cattails in the central portion.

Impoundments, between the slumps, and seepage areas have variable vegetation ranging from willow and red osier dogwood in the moist to wet areas and swamp birch, sedge mosses, and willow in the areas of prolonged ponding or seepage.

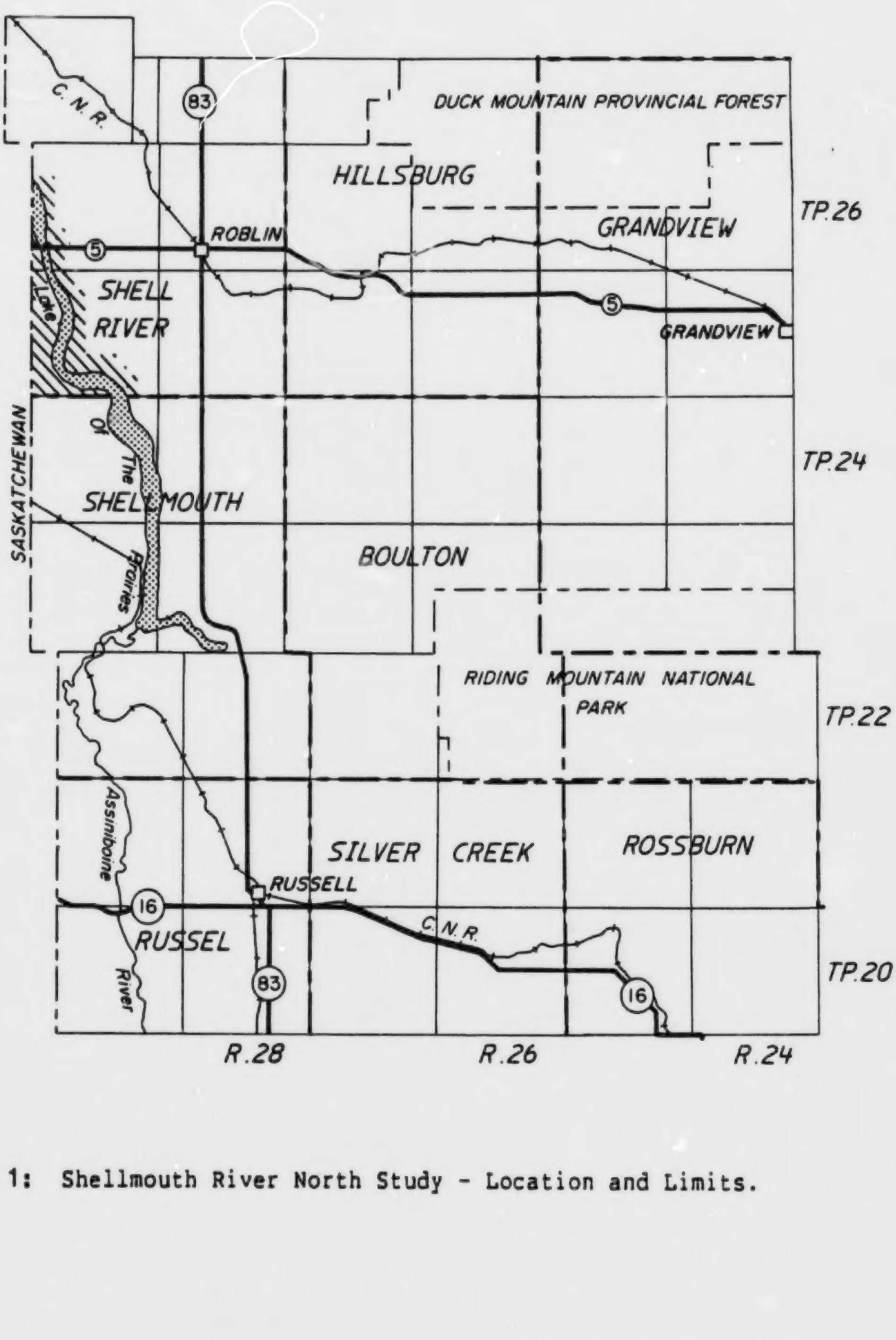
C.N.R.
83
DUCK MOUNTAIN PROVINCIAL FOREST
HILLSBURG
TP.26
ROBLIN
5
GRANDVIEW
SHELL
RIVER
5
GRANDVIEW
Lake Of The Prairies
SASKATCHEWAN
TP.24
SHELLMOUTH
BOULTON
RIDING MOUNTAIN NATIONAL PARK
TP.22
Assiniboine River
SILVER
CREEK
ROSSBURN
RUSSELL
16
RUSSEL
C.N.R.
83
16
TP.20
R.28
R.26
R.24

Figure 1: Shellmouth River North Study - Location and Limits.

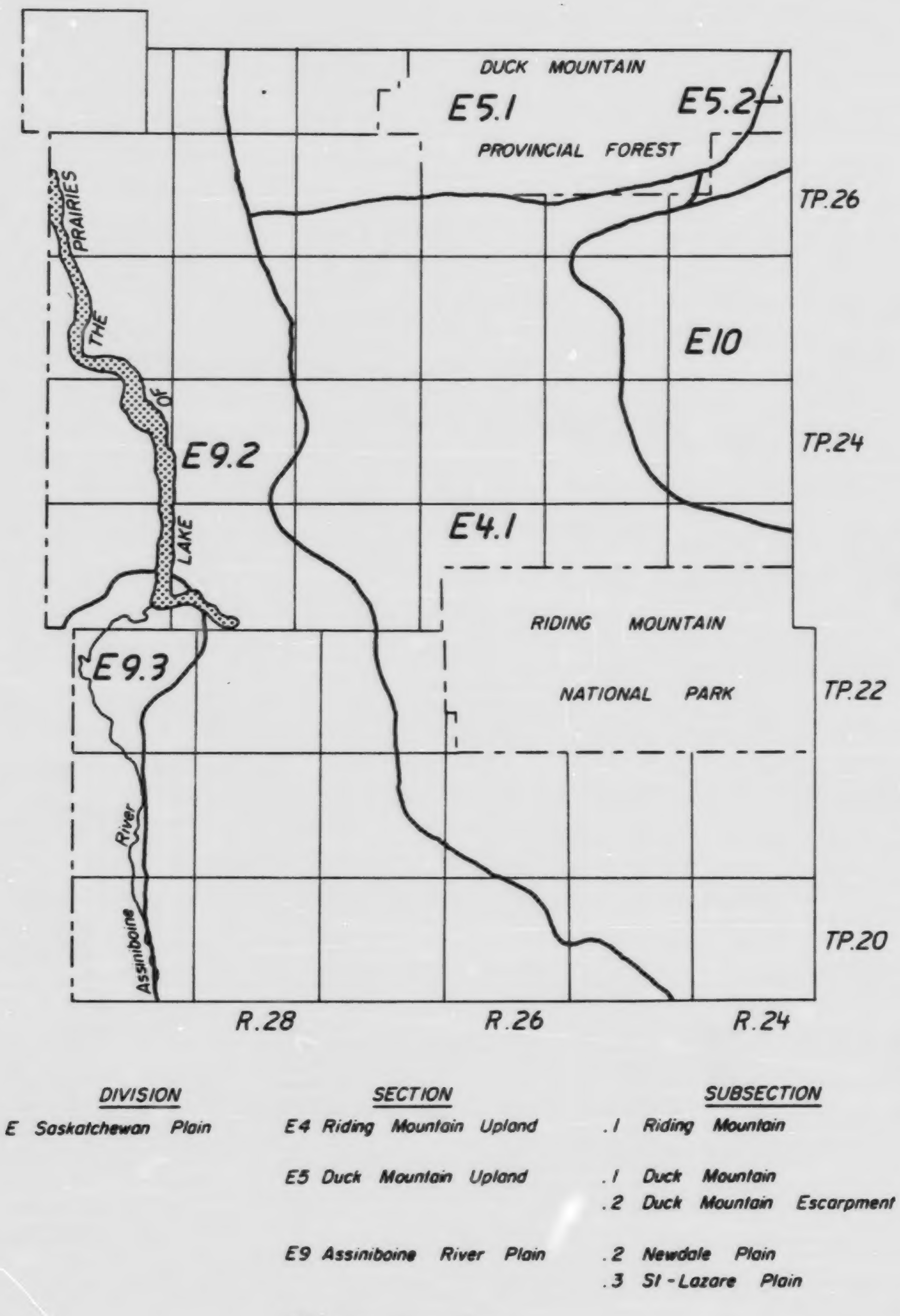
DUCK MOUNTAIN
E5.1
E5.2
PROVINCIAL FOREST
TP.26
THE PRAIRIES
E10
OF
TP.24
E9.2
E4.1
LAKE
RIDING MOUNTAIN
NATIONAL PARK
E9.3
TP.22
River
Assiniboine
TP.20
R.28
R.26
R.24
DIVISION
E Saskatchewan Plain
SECTION
E4 Riding Mountain Upland
E5 Duck Mountain Upland
E9 Assiniboine River Plain
E10 Valley River Plain
SUBSECTION
.1 Riding Mountain
.1 Duck Mountain
.2 Duck Mountain Escarpment
.2 Newdale Plain
.3 St-Lazare Plain

Figure 2: Physiographic Regions in the Vicinity of the Shellmouth River North Study.

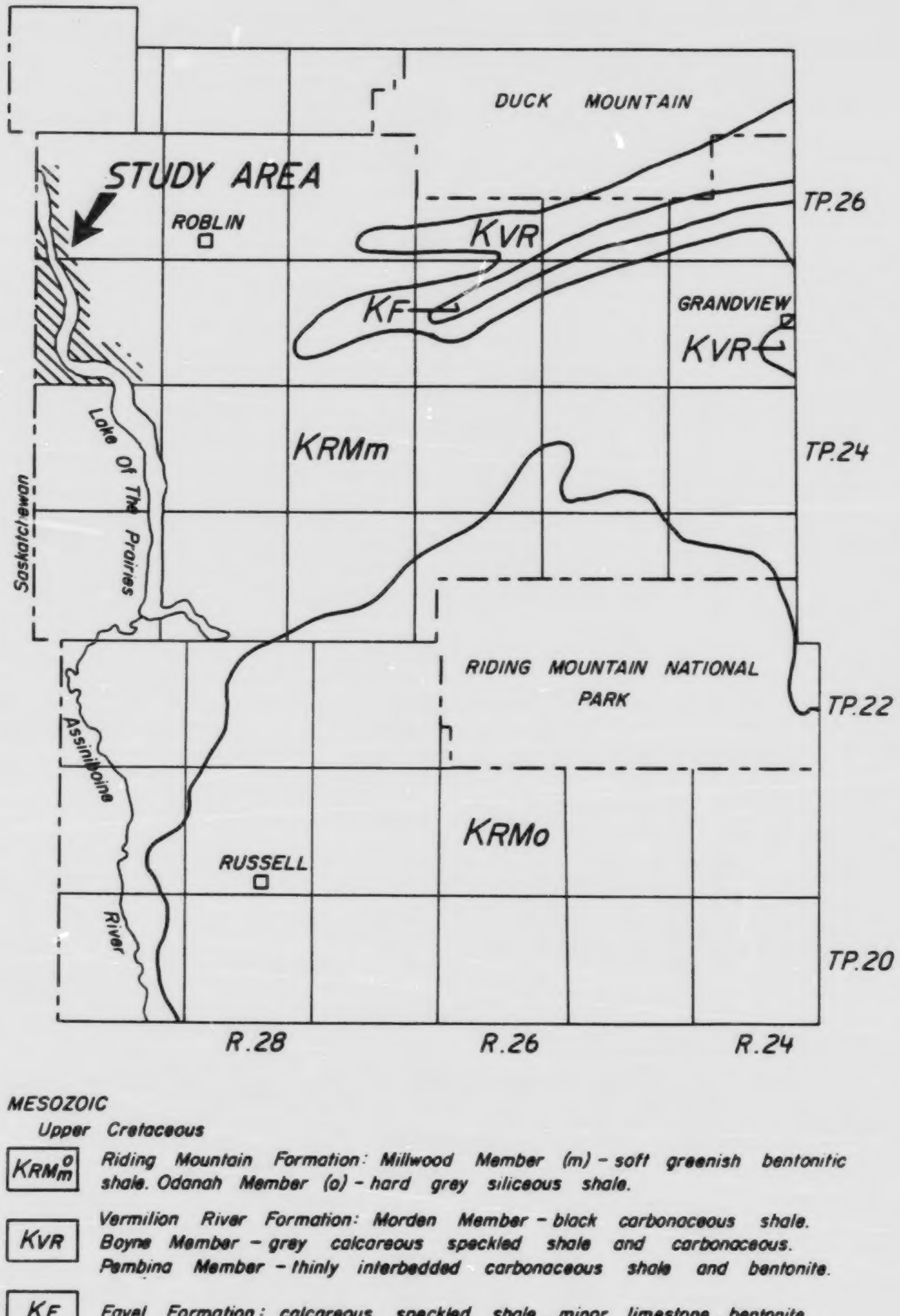
DUCK MOUNTAIN
STUDY AREA
ROBLIN
KVR
KF
GRANDVIEW
KVR
TP.26
KRMm
TP.24
Saskatchewan
Lake Of The Prairies
RIDING MOUNTAIN NATIONAL PARK
TP.22
Assiniboine River
KRMo
RUSSELL
TP.20
R.28
R.26
R.24
MESOZOIC
Upper Cretaceous
KRM$^{o}_{m}$ Riding Mountain Formation: Millwood Member (m) - soft greenish bentonitic shale. Odanah Member (o) - hard grey siliceous shale.
KVR Vermilion River Formation: Morden Member - black carbonaceous shale. Boyne Member - grey calcareous speckled shale and carbonaceous. Pembina Member - thinly interbedded carbonaceous shale and bentonite.
KF Favel Formation: calcareous speckled shale, minor limestone, bentonite.

Figure 3: Bedrock Geology of the Shellmouth River North Study.

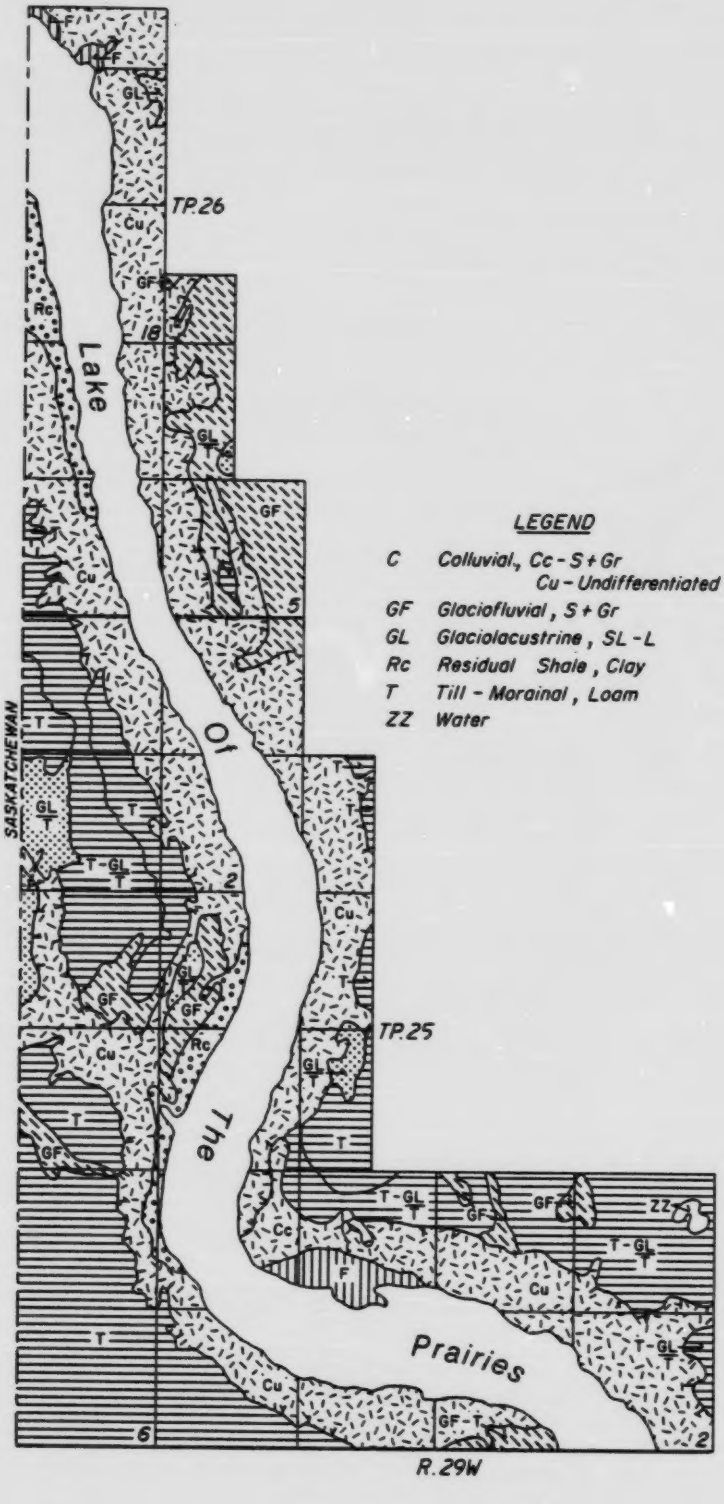
LEGEND
C Colluvial, Cc - S + Gr
Cu - Undifferentiated
GF Glaciofluvial, S + Gr
GL Glaciolacustrine, SL - L
Rc Residual Shale, Clay
T Till - Morainal, Loam
ZZ Water
Lake Of The Prairies
TP.26
TP.25
R.29W
SASKATCHEWAN
18
5
2
6
2
GF
GL
Cu
Rc
T
T-GL
Cc
F
GF-T
ZZ

Figure 4: Surface Deposits of the Shellmouth River North Study.

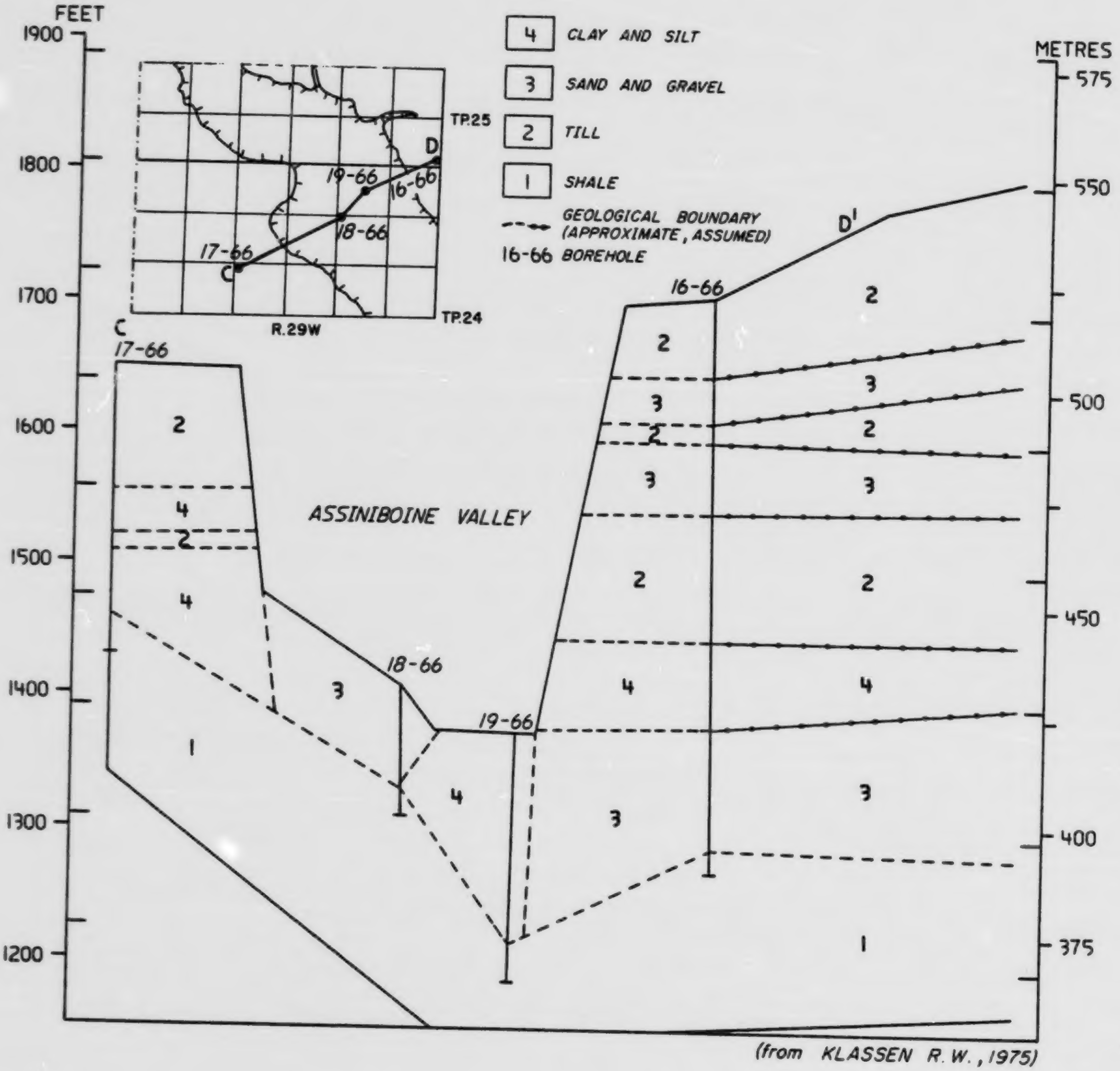
FEET
1900
1800
1700
1600
1500
1400
1300
1200
METRES
575
550
500
450
400
375
TP.25
TP.24
R.29W
D
19-66
16-66
18-66
17-66
C
4 CLAY AND SILT
3 SAND AND GRAVEL
2 TILL
1 SHALE
GEOLOGICAL BOUNDARY (APPROXIMATE, ASSUMED)
16-66 BOREHOLE
C
17-66
D'
16-66
18-66
19-66
ASSINIBOINE VALLEY
1
2
3
4
(from KLASSEN R.W., 1975)

Figure 5: Cross-Section of the Stratigraphy at the South Limit of the Shellmouth River North Study.

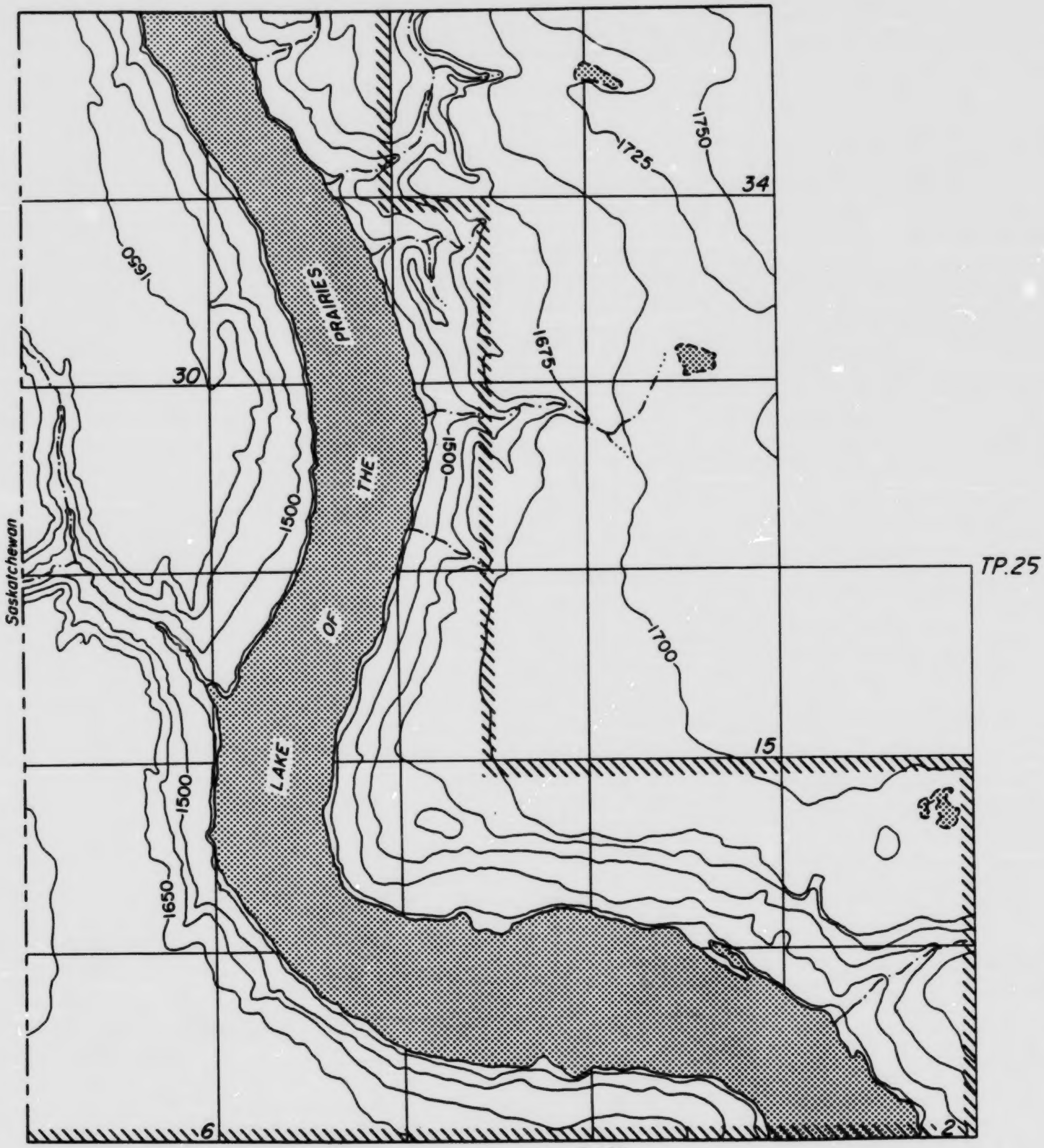
LAKE OF THE PRAIRIES
Saskatchewan
TP.25
R.29
1750
1725
1700
1675
1650
1500
34
30
15
6
2

Figure 6: Relief and Drainage of the Shellmouth River North Study.

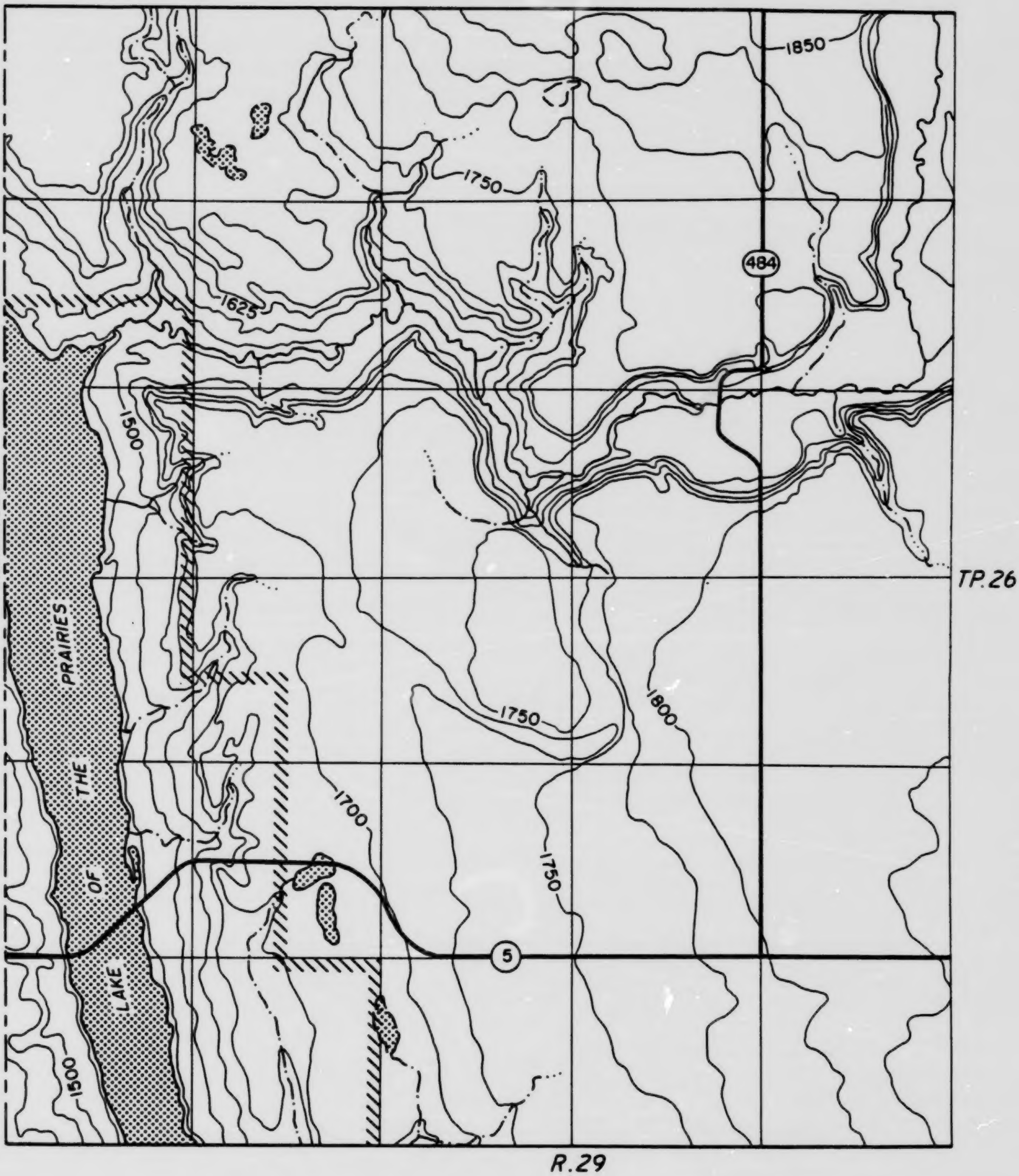
1850
1750
484
1625
1500
Saskatchewan
PRAIRIES
THE
OF
LAKE
TP.26
1750
1800
1700
1750
5
1500
R.29

TABLE 2

Climatic Parameters for the Stations near the Shellmouth Reservoir North Area

Parameters	Reference	Probability	Russell	Rossburn	Yorkton	Kamsack
Elevation m.a.s.l.	1		560	581	504	440
Temperature °c (mean annual)	1		0.7	1.6	1.2	0.9
Precipitation mm (mean annual)	3		451	539	434	385
Frost Free Period 0°C (days)	2	50	102	113		
		25	89	103		
		10	77	94		
Frost Free Period -2.2°C (days)	2	50	123	134		
		25	110	122		
		10	98	110		
Corn Heat Units (base 10°C)	2	50	2074	2197		
		25	1937	2041		
		10	1812	1898		
Growing Degree Days (base 5.5°C)	2	50	1393	1454		
		25	1310	1370		
		10	1235	1292		
Water Deficit mm Soft dough stage Wheat	2	50	20.2	(+6.0)		
		25	55.9	35.2		
		10	88.5	73.7		

References:

1. Environment Canada, 1975.
2. Dunlop, 1981.
3. Environment Canada, 1982.

PART 2

METHODOLOGY

2.1 FIELD INVESTIGATIONS

Detailed soil mapping was conducted at Survey Intensity Level 2, and a publication scale of 1:20,000 (Mapping System W.G. 1981). At this scale, the minimum practical size of delineations of significant soil areas is approximately one hectare.

Soil mapping was conducted by examining soil profiles to depths of one meter along selected traverses in each section. In areas with limited access, soils were examined adjacent to roads and trails, and along selected short traverses. In cultivated or accessible areas the soils were examined at about 150 meter intervals along each traverse; two traverses were made per section of land. Sites adjacent to the traverse and along road allowances were also examined to provide additional ground truthing and to help locate soil boundaries between sections. This field method provided approximately 25 to 30 inspection sites per section or one site per 10 ha. At each location, detailed information was recorded as to landform, drainage, parent material, and soil profile characteristics for the site and the surrounding terrain. This data, recorded on daily field forms, was later input into the Canada Soil Information System (CanSIS) data bank.

Boundaries delineating map units in the survey area were compiled on an aerial photographic base at a scale of 1:20,000 (1 cm = 0.21 km).

2.2 UNITS OF MAPPING

The taxonomic category used to classify soils is the soil series. It is defined as a naturally occurring soil body such that any profile within the body has a similar number and arrangement of horizons, whose color, texture, structure, consistency, thickness, reaction and composition are within a narrowly defined range. Soil profiles varying only slightly from described series are sometimes encountered. If significant acreages of these soils are encountered, a soil series variant is established. The soil variant is named after the soil series it resembles as well as its differentiating feature.

The delineation of map units, whether described by one, two or three soil series, is not exact. Map units vary with local topography, drainage, erosion and soil profile properties. The decision to outline and label any given area is based on interpretation and extrapolation of observed soil and landscape features and air photo interpretation. The delineation of soil boundaries serves to separate soils having properties and conditions which are significant for potential use as field management units.

There are two kinds of map units used in the resurvey of soils in Manitoba. They are simple map units and compound map units.

Simple map units usually contain one dominant soil series, the properties of which vary within narrow limits. The map unit can also contain a small proportion, usually less than 15 percent, of related but unlike soils and phases. The proportion of such undescribed inclusions tends to increase as soil inspection density decreases or where soil variability has no obvious predictable occurrence. Simple map units are normally named after the dominant series.

Compound map units usually contain significant proportions of two or more unlike soil series. These soils are related geographically but cannot be delineated separately because of the intricacy of soil pattern, the cartographic limitations of map scale and survey effort. In many compound map units differences in soils and their related characteristics are strongly contrasting. Dominant, subdominant and minor (if strongly contrasting) soil series are identified, and their percentile proportions within each map delineation is specified. A user must refer to two or more named soil series in the soil legend and soil report to obtain a complete description of a compound map unit.

A soil complex is another type of compound map unit. It contains two or more named or unnamed soils which occur in unspecified proportions. This map unit is used where soil variability is so complex and unpredictable that soils cannot be delineated separately, nor can their relative proportions be estimated. A user will need only to refer to one map unit name in the soil legend and soil report to obtain a complete description of the soil complex.

Very often, it is desirable to indicate by map unit symbol, variations in soil properties or landscape features likely to affect soil management, and include erosion, slope class, stoniness and salinity. The effect of each one of these four properties or features are indicated according to the degree or magnitude and designated in the following manner:

Erosion

x - none or only very slight erosion
1 - weakly eroded
2 - moderately eroded
3 - severely eroded
0 - overblown

Slope Class

x - slope classes a-b, i.e. less than 2 percent slope is considered normal for the soil series
c - 2 to 5 percent slope
d - 5 to 9 percent slope
e - 9 to 15 percent slope
f - 15 to 30 percent slope
g - 30 to 45 percent slope
h - 45 to 70 percent slope
i - 70 to 100 percent slope

Stoniness

x - non stony
1 - slightly stony
2 - moderately stony
3 - very stony
4 - exceedingly stony
5 - excessively stony

Salinity

x - non saline
s - weakly saline
t - moderately saline
u - strongly saline

The convention employed to indicate these features in the map symbol is as follows:

If none of the above properties are observed to be significant, the map unit symbol representing the pure or unaffected soil series is used without modifiers.

If one or more phase features are used, the appropriate letter or number is placed below the soil series symbol in one of four designated locations in the map unit symbol. The designated order is erosion, slope class, stoniness and finally, salinity. If a particular feature is not observed to be significant, an x is used in its appropriate designated location in the map symbol.

For example, the compound map unit symbols coded:

```
 7      3
ECK  - RBN
----   ----
xc1x
```

Indicates that 70 percent of the delineated area has the profile properties of the Erickson series (ECK) with little or no erosion (x), on slopes of 2 to 5 percent (d), slightly stony (1), minimal salts (x) and 30 percent of the delineated area has the profile properties of the Roblin series (RBN).

Definitions of the erosion, slope, topography, stoniness and salinity classes are given in the Glossary.

2.3 SAMPLING

During the course of field investigations and mapping, soil samples were collected at selected locations for soil characterization, salinity and engineering properties. One profile was described in detail and sampled for soil characterization analysis. Soils were sampled for salinity studies in areas where salinity was observed or suspected; samples were taken at the 10 to 25 cm, and 50 to 60 cm depths for electrical conductivity measurements and soluble salts.

PART 3

DEVELOPMENT, CLASSIFICATION AND DESCRIPTION OF THE SOILS

This section describes the important characteristics of the soils and their relationship to the factors of soil development that are operative in the study area.

3.1 SOIL DEVELOPMENT

Soil is produced through the action of soil-forming processes on soil parent material deposited or accumulated by geologic forces. The characteristics of the soil at any place are determined by the physical and mineralogical composition of the original geologic material, the climate under which the soil material has accumulated and existed, the plant and animal life on and in the soil, the relief and drainage, the length of time the forces of development have acted on the materials, and the influence of human activity.

When viewed in vertical cross-section, a mature soil is seen to consist of various layers called soil horizons. The main or master horizons have been designated by the letters A, B, and C for mineral horizons (Canada Soil Survey Committee 1978).

The A and B horizons are a reflection of the genetic forces operating on the parent material and together they are termed the solum of the soil. In general, A horizons or surface layers are subjected to the greatest amount of weathering and leaching and/or organic matter accumulation. The B horizons, lying immediately below the A horizon, contain most of the material leached from the A horizons or have been otherwise altered by soil forming processes. The C horizons represent the relatively unweathered parent material from which the solum has developed.

3.2 SOIL CLASSIFICATION

The degree of soil development is related to the regional climate which affects the degree of leaching, translocation and accumulation of soluble and colloidal fractions of the soil. The soils have developed under a cool subhumid Boreal climate which provides sufficient heat and moisture during the growing season to produce an aspen grove-grassland vegetation community; the soils at the higher elevation were in transition to an aspen-white spruce vegetation. The soils are dominantly Chernozemic Blacks with areas of Dark Gray adjacent to and within the valley and in transition to the areas at a higher elevation.

Poor drainage associated with depressional areas causes the soil environment to change from an oxidative state to a depleted oxygen or reductive state. The characteristics of soils with restricted drainage are: dull (gleyed) soil colors, the presence of mottles of iron and manganese, the presence of lime carbonate near the surface, and a high water table. Poorly drained mineral soils in the area are dominantly Humic Luvic Gleysols. These soils have dark colored Ap or Aheg horizons with an accumulation of organic matter, and a clayey Bt horizon. In the cultivated state, these soils give a light gray surface color to depressional areas. The very deep depressions usually contain permanent water bodies and are surrounded by Rego Humic Gleysolic soils.

Very poorly drained depressional sites result in accumulation of shallow organic materials and the soils are classified dominantly as Terric Mesisols. The most common organic parent material in such areas is moderately decomposed (mesic), non-woody fen peat.

3.3 PARENT MATERIALS, SOIL MOISTURE REGIME AND SOLUM TYPES

In similar climatic zones, soils vary significantly because of differences in texture and mineralogical composition of the parent materials and natural drainage or moisture regime. Soils developed on the crest of undulating to hummocky terrain generally have shallower profiles due to less effective water movement into the soil from snowmelt and rainfall, while soils in the mid to lower slope positions have deeper soil profiles. Soils in the potholes of higher landscapes have deep leached solum, while poorly drained soils in the lower landscapes and along creeks have shallow, carbonated profiles, and may contain considerable salts.

The soil parent material, soil profile type and related moisture regimes become the dominant features used in classifying and mapping soils. These features can be organized readily to show the relationship of parent material, solum type and drainage or moisture regime as in Tables 3 and 4.

Table 3. Classification Key of the Soils Mapped in the Soil Study Area.

	Map Symbol
1. Morainal till	
1.1 Deep (>1 m) moderately to strongly clacareous, fine loamy (L, CL textured) morainal deposits derived from shale, limestone and granitic materials.	
a) Well drained	
Erickson series (Orthic Dark Gray)	ECK
Newdale series (Orthic Black)	NDL
b) Poorly drained	
Roblin series (Humic Luvic Gleysol)*	RBN
Penrith series (Humic Luvic Gleysol)**	PEN
*Associated with Dark Gray and Luvisols **Associated with Blacks	
2. Deep, stratified glacial fluvial sandy and gravelly deposits.	
2.1 Deep (>1 m) moderately to strongly calcareous (very coarse to coarse textured), stratified sandy to sandy skeletal (S, GrS) deltaic, beach or outwash deposits of dominantly limestone and granitic origin.	
a) Well drained	
Leary series (Orthic Dark Gray)	LRY
Marringhurst series (Calcareous Black)	MRH
b) Poorly drained	
Fortina series (Rego Humic Gleysol)	FTN
3. Lacustrine parent materials.	
3.1 Deep (>1 m) moderately calcareous, loamy fine sand to fine sand to fine sandy loam textured sediments.	
a) Well drained	
Davidson series (Orthic Dark Gray)	DVD
4. Lacustrine over fluvial veneers on morainal till.	
4.1 Shallow (<1 m), moderately calcareous, fine sand to fine sandy loam textured sediments overlying moderate to strongly calcareous, loam to clay loam textured glacial till derived from shales, limestone, and granitic rocks. A thin, gravelly layer generally occurs at the till contact.	

a) Well drained
   Ozerna series (Orthic Dark Gray) OZA
   Jaymar series (Orthic Black) JAY

b) Imperfectly drained
   Longdens series (Gleyed Eluviated Black) LGD

c) Poorly drained
   Marsden series (Rego Humic Gleysol) MDN

5. Fluvial material (terrace and recent deposits)

5.1 Deep (>1 m) stratified loamy (SL, L, CL) fluvial, moderately to strongly calcareous sediments.

a) Moderately well drained
   Mowbray series (Cumulic Regosol) MOW

b) Imperfectly drained
   Levine series (Gleyed Cumulic Regosol) LEI

c) Poorly drained
   Basker series (Rego Humic Gleysol) BKR

5.2 Deep (>1 m) stratified clayey (sic, c, sc) fluvial moderately to strongly clacareous sediments.

a) Imperfectly drained
   Assiniboine series (Gleyed Cumulic Regosol) ASB

b) Poorly drained
   Kerran series (Rego Humic Gleysol) KRN

6. Weathered shale bedrock.

6.1 Soils developed on a veneer (25-90 cm) weakly calcareous clayey deposits or weathered shale overlying non to weakly clacareous shale bedrock.

a) Well to moderately well
   Benton series (Solonetzic Dark Gray) BEO

7. Mass wasting materials (Colluvial)

7.1 Poorly to non-sorted materials of variable texture and composition deposited at various positions of slopes and inclines through gravity movement.

a) St. Lazare Complex	SZR
- dominantly mixed, calcareous till (Orthic Dark Gray and Dark Gray Luvisol)	SZR1
- dominantly sand and gravel (Calcareous Black, Orthic Dark Gray)	SZR2
- clay and thin till over shale clay (Solonetzic Dark Gray, Orthic Dark Gray)	SZR3
- mixed materials, sand, gravel, clay and till (Orthic Dark Gray, Calcareous Black, Solonetzic Dark Gray)	SZR4
- variable materials with peaty surface in wet and seep areas (Terric Mesisol, Typic Mesisol, Rego Humic Gleysol peaty)	SZR5

8. Miscellaneous land area

Land areas influenced by fluctuating water levels that vary in depth depending on the season.

- marsh	MHC
- water	ZZ

TABLE 4

The Soil Series of the Shellmouth Reservoir North Study Area Arranged in Relation to Soil Moisture Class, Subgroup and Parent Material

		Parent Material								
		Glacial Till	Fluvial or Lacustrine					Weathered Shale	Colluvial	Misc.
		Fine Loamy(L-CL)	Sandy Skeletal	Sandy	Loamy over	Recent		Weakly calcareous clay	Variable material along valley slopes (C)	
Soil Moisture Class	Subgroup	Mod. to very strongly calcareous of mixed granitic, limestone & shale	Stratified sand & gravel	Weakly calcareous FS to LFS	5-75 cm S or Gr over glacial till	Clayey, stratified	Loamy, stratified			
Well to moderately well	O.DG	Erickson(ECK)	Leary(LRY)	Davidson(DVD)	Ozerna(OZA)				St.Lazare(SZR)	
	O.BL	Newdale(NDL)			Jaymar(JAY)					
	Ca.BL		Marringhurst(MRH)							
	SZ.DG							Benton(BEO)		
	Cu.R						Mowbray(MOW)			
Imperfect	GLE.BL				Longdens(LGD)					
	GLCU.R					Assiniboine(ASB)	Levine(LEI)			
Poor	R.HG		Fortina(FTN)		Marsden(MDN)	Kerran(KRN)	Basker(BKR)			
	HU.LG	Roblin(RBN) A								Marsh(MHC)
		Penrith(PEN) B								Water(ZZ)

A (associated with Dark Gray and Luvisol soils)
B (associated with Black soils)

C SZR1 dom. till
SZR2 dom. S, Gr
SZR3 clay and thin till over shale clay
SZR4 mixed sand, gravel, clay, till
SZR5 variable, peaty, wet or seep areas

3.4 DESCRIPTION OF THE SOILS

The soil series of the study area are described in alphabetical order and include a general description of the soil profile, its texture, parent material characteristics, topography and natural drainage.

Information on the suitability and arrangement of each soil for agriculture, engineering, urban and recreational uses is given in Part 4 of the report.

Assiniboine Series (ASB)

The Assiniboine series consists of imperfectly drained Gleyed Cumulic Regosol soils developed on moderately to strongly calcareous, stratified, dominantly clayey (SiC, C) recent deposits with stratum of silty clay loam and clay loam texture. They occur in the flood plain of stream channels. The permeability is moderately slow to slow, and runoff is slow. The topography is level to gently undulating. The native vegetation consists of ash, elm with tall prairie to prairie meadow grasses.

The Assiniboine soil is characterized by a weak dark gray to gray Ah or Ap horizon that is somewhat darker than the C horizon. Under moist conditions the surface looks quite dark, but on drying, lightens up considerably. The C horizon is stratified, and may contain dark stratum representing former surfaces. The soils contain iron stains and mottles in the subsoil.

Basker Series (BKR)

The Basker series is characterized by a Rego Humic Gleysol soil profile that is developed on moderately to strongly calcareous, loamy textured, stratified fluvial sediments. These soils occur as bottom land in the lower positions along streams and channels in close association with the better drained Levine soils. They are subject to flooding when water levels are high during spring runoff or after heavy rains, and remain saturated for a significant period following inundation. The stratified parent material is dominantly loam to clay loam in texture, but coarser or finer textured layers may be present. Native vegetation consists of dominantly sedge, rushes and willow shrubs.

The Basker soil profile has a variably thick (6 to 30 cm), moderately decomposed organic surface layer and a thin, carbonated, dark gray Ah horizon, 3 to 8 cm thick. The subsoil is stratified with loamy textured layers having olive to olive gray colors and may have some iron mottles in the sandy strata. Black, organic matter, rich layers may occur, indicating former soil surfaces. Soils having surface organic layers greater than 15 cm thick were designated as Basker, peaty phase.

Benton Series (BEO)

The Benton series is characterized by a Dark Gray Solonetz solum developed under moderately well to well drained conditions on clayey material that occur as a thin veneer of clay deposits or as weathered and softened shale overlying non to weakly calcareous shale bedrock. These soils have a hard columnar structure due to presence of sufficient sodium in solution and on the cation exchange complex. Sodium salts are associated with some of the underlying shale beds. They occur on gently sloping to hummocky, dissected landscapes along the mid to lower slopes of the valley. Slopes ranging from 3 to 9 percent are common; steeper slopes may occur in some areas. Runoff is moderate to rapid; permeability is very slow.

The solum of this soil has a thin LH horizon 2 to 4 cm thick, a dark gray Ahe horizon 3 to 10 cm thick, a very thin Ae immediately above the columnar Bn or Bnt horizon. The Bn horizon may be subdivided into a Bn1 and Bn2 based on structure. The Bn1 is 15 to 30 cm thick, strong columnar and very hard when dry, very plastic when moist. The Bn2 is massive breaking to weak angular blocky structure and is very plastic when moist. The thickness of the Bn2 varies from 10 to 25 cm. The underlying BC or C horizons, of variable thickness are usually present above the shale bedrock. The solum depth may vary from 55 to 75 cm; depth to the shale varies to 90 cm of the surface. Gypsum and jarosite are commonly found in the shale bedrock.

Most of these soils have been utilized as natural grazing areas. Under cultivation, the Ahe, Ae and Bn horizons become incorporated into the Ap layer; the plow layer may have a massive to angular blocky structure that becomes difficult to till when wet because of stickiness, or when dry because of very hard consistence.

Davidson Series (DVD)

The Davidson series is characterized by well to moderately well drained, Orthic Dark Gray soils developed on moderately calcareous sandy, lacustrine sediments. Surface textures are dominantly fine sandy loam, but vary from loamy sand to very fine sandy loam. Topography is irregular with slopes ranging from level (less than 2 percent) to moderate slopes (9 to 15 percent); surface runoff is moderate to slow; permeability is rapid. The depth of sand can vary from 1 to 3 meters overlying morainal till. Present land use varies from cultivated crop land, to improved pasture and forage, or natural grazing.

Davidson soils are characterized by moderately deep profiles, of about 53 cm, and ranging in thickness from 30 to 115 cm. A typical profile has a dark gray Ap or Ahe surface horizon, 14 to 45 cm thick (average 27 cm) and a very dark grayish brown Bm, Btj, or Bt horizon. A light gray lime carbonate layer (Cca horizon) may be present between the B and C horizon.

Davidson soils are more permeable and less stony than the similar finer textured Erickson soils, loamy textured Onanole series or the Banks and Ozerna soils which are underlain by compact loamy till. They are less arid and more fertile than the gravelly Leary soils.

Erickson Series (ECK)

The Erickson series is characterized by an Orthic Dark Gray solum on moderately to strongly calcareous, loamy (L-CL) morainal till of limestone, granitic and shale origin. These soils are moderately well to rapidly drained and occur in mid to crest positions of undulating to hummocky landscapes with slopes ranging from 2 to 15 percent. They occur at somewhat higher elevations than those of the Newdale soils. Surface runoff is moderate to rapid; permeability is moderate to moderately slow. Most of these soils are presently cultivated;

native vegetation consists dominantly of aspen.

The solum has a loamy dark gray Ap horizon, 14 to 20 cm thick, a variable Ahe horizon, a dark yellowish brown clay loam to light clay Bt or Btj horizon, 20 to 30 cm thick, and a transitional BC horizon approximately 20 cm thick. A pale brown lime accumulation layer, 15 to 20 cm thick is usually present; some lime accumulation may occur along cracks in the Ck horizon.

In the study area, the average A horizon thickness is 24 cm and varies from 15 to 35 cm. The average solum depth is 65 cm and varies from 35 to 100 cm.

Minor amount of imperfectly drained Petlura series (Gleyed Dark Gray) and the poorly drained Roblin series are included in the Erickson mapping units.

Fortina Series (FTN)

The Fortina series is Rego Humic Gleysols developed on moderately to strongly calcareous, stratified outwash and glacial fluvial deposits of medium sand to gravelly texture. These poorly drained soils occur on level to depressional topography in association with the Marringhurst soils. Runoff is very slow to negligible; permeability is moderately rapid to rapid, but restricted during periods when free water is at or near the surface. Natural vegetation consists of sedges, cattails, and some willow.

The soil is characterized by a thin, moderately decomposed organic layer, 1 to 4 cm, a very dark gray Ah horizon, 10 to 20 cm thick, and olive gray AC horizon with yellowish brown mottles. A lime carbonate horizon is usually present at or above a coarser lense or strata.

Jaymar Series (JAY)

The Jaymar series are well to moderately well drained, Orthic Black soils developed on a sequence of soil materials composed of a thin mantle (25 to 60 cm) of moderately to strongly calcareous loamy sediments over thin (10 to 40 cm) medium sand to gravel strata, over a strongly calcareous loamy (loam to clay loam) glacial till of shale, limestone and granitic origin. The soils occur on gently sloping topography; runoff is moderate; permeability is moderate to rapid in the upper loamy and coarser strata and moderately slow in the underlying till.

The solum has a very dark gray Ap and Ah horizon 25 to 35 cm thick, a brown to dark grayish brown Bm horizon 8 to 12 cm thick and a thin BC horizon. A lime accumulation layer occurs at the contact of the loamy sediments and the coarser strata.

Kerran Series (KRN)

The Kerran series consists of poorly to very poorly drained carbonated Rego Humic Gleysol and carbonated Rego Gleysol soils on moderately to strongly calcareous, stratified, dominantly clayey (SiC, C) recent deposits with stratum of silty clay loam and clay loam texture. They occur in the level to depressional sites in the floodplain of stream channels and are subject to flooding, or are saturated for a considerable period of time in the spring or following heavy rains. The native vegetation consists of dominantly sedges, rushes and willow.

These soils are characterized by a thin organic layer of 1 to 2 cm, and either a weakly developed dark gray Ahk horizon of 10 to 15 cm thick or a light gray to pale brown recent depositional (Ck) layer. The C horizon is usually mottled, stratified, and may contain former surface layers.

Leary Series (LRY)

The Leary series consists of well to excessively drained Orthic Dark Gray soils developed on sand and gravel beach and outwash deposits. Commonly, there is a thin sandy to loamy surface mantle over the coarser material. The average thickness of its profile is greater than 50 cm with an average A horizon thickness of 20 cm. The topography is very gently to gently sloping. Surface runoff is moderately slow.

Levine Series (LEI)

The Levine series is characterized by a Gleyed Cumulic Regosol profile on stratified, loamy textured fluvial sediments. These soils are imperfectly drained and subject to periodic inundation due to flooding. They occur within the floodplain of meandering creeks and streams. The topography is level to undulating or irregularly sloping due to the varied landform along streams, terraces, scrolled, or inclined meanders. Runoff is slow to moderately slow; permeability is moderate, but restricted during periods of high water flow at runoff.

The Levine soil profile has a dark gray to grayish brown surface A horizon (Ap when cultivated), 10 to 15 cm thick, and underlying strata that vary in color and texture; colors range from pale brown to olive yellow with very dark layers indicating former surface horizons. Yellowish brown mottles are common throughout the subsoils.

In the study area, some soils with thicker dark surfaces have been included with the Levine series. These Chernozem-like soils with the thicker dark layers are adjacent to cultivated soils with considerable slopes and have received additional deposition from upperslope erosion in conjunction with periodic accretion by flooding.

Longdens Series (LGD)

The Longdens series are characterized by a Gleyed Eluviated Black solum developed under imperfectly drained conditions on a thin veneer (usually less than 1 m) of moderately to strongly calcareous coarse loamy (SL to L textures) fluvial and lacustrine sediments overlying strongly calcareous loamy (L to CL) glacial till of shale, limestone and granitic origin. A sand or gravel lense ranging from 5 to 60 cm thick commonly occurs between the loamy surface sediments and the till. These soils are found on the lower to midslope positions and have nearly level to gentle slopes. Runoff is moderately slow; permeability is moderately rapid in the overlay and moderate to moderately slow in the underlying till.

The solum has a very dark gray to dark gray Ap horizon 15 to 18 cm thick, a thin Ahe or Ae commonly less than 7.5 cm and a weakly mottled brown to dark grayish brown Bm or Btj horizon of 20 to 40 cm thick. The solum varies with the depth of the sandy loam to loam overlay and the amount of coarser fragments in the sandy or gravelly layer. Some of these soils have sand or loamy sand textured surfaces that may extend to the underlying till at 75 to 95 cm.

The fluvial or lacustrine sediments are generally thicker on the Longdens soils in comparison to the better drained Jaymar series.

Marsh Complex (MHC)

The Marsh complex consists of carbonated Rego Humic Gleysols developed on mixed materials derived from glacial, lacustrine and recent alluvial sediments. They are saturated or inundated for most of the year. These soils may have thin LH horizons and layers high in humic organic material. The underlying mineral material is usually strongly reduced and has very dull colors in the olive and greenish gray hues. These soils are strongly carbonated to the surface and occur immediately surrounding most permanent water bodies in the map area. The topography is usually depressional to level and the native vegetation consists entirely of hydrophytic vegetation such as rushes, reeds and sedges. In some areas, scattered surface boulders may occur; stony sub-soils are common.

Marringhurst Series (MRH)

The Marringhurst series consists of moderately well to well drained, Calcareous Black soils developed on moderately to strongly calcareous stratified outwash and glaciofluvial deposits of medium sand to gravelly texture. These soils occur on very gently sloping to irregular, moderately rolling topography. On the complex topographic units, they occur as a complex with other soils. Runoff is moderate to moderately rapid; permeability is very rapid. The soil materials are stratified with strata ranging in texture from fine sand to coarse gravel.

The soil is characterized by a very dark gray to very dark grayish brown Ah horizon, 14 to 18 cm thick and a dark brown to brown Bmk horizon, 10 to 18 cm thick. The solum varies with the depth to a coarser gravelly strata. The lime accumulation layer occurs in the coarser gravelly strata and varies from 20 to 30 cm thick; secondary carbonate accumulation on the lower half of grains and pebbles .

Mowbray Series (MOW)

The Mowbray series is characterized by a Cumulic Regosol solum on moderately well to well drained, stratified, moderately to strongly calcareous, loamy (SiL, L, SiCL, CL textures) fluvial sediments. The soils occur on level to gently sloping terrain in proximity to major streams or as terraces along former glacial meltwater channels. Present flood hazard is considered to be very slight. Surface runoff varies from slow to moderate depending on the slope. Permeability is variable ranging from moderately rapid in the coarser textured layers to moderately slow in the finer textured layers. Most of the soils are cultivated and occur in small irregular shaped fields due to such obstructions as former terrace scarps, meander scars, or slumps.

The soil exhibits slight profile development and may vary in structure and color development that approach the Black or Dark Gray color criteria, particularly in the moist condition. Surface colors are commonly dark grayish brown and range from dark gray and gray to brown or pale brown; the underlying layer is usually lighter in color. In some parts of the landscape, the solum, in the moist state, appears to have a Bmk exhibiting weak subangular to blocky structure.

On the terraces along the Assiniboine River, some of the stratified layers in these soils may contain shaly sands or gravel. These layers have rapid permeability; if they occur within rooting depth, root development of crops may adversely be affected since these layers have low water retention capacity as well as horizontal shale orientation. The presence of several alternate lighter and darker colored layers indicating presence of former surfaces that subsequently have been buried are common in these soils.

Newdale Series (NDL)

The Newdale series is characterized by an Orthic Black solum on moderately to strongly calcareous, loamy (L-CL) morainal till of limestone, granitic and shale origin. These soils are moderately well to well drained and occur in mid to upper slope positions of undulating to hummocky landscapes. Surface runoff is moderate to moderately rapid; permeability is moderately slow. Most of these soils are presently cultivated; they have formed under intermixed aspen grove and grassland vegetation.

The Newdale solum has a very dark gray Ah horizon, commonly 25 cm thick and ranging from 15 to 35 cm, a dark brown Bm horizon, 10 to 30 cm thick, and a transitional BC horizon, 3 to 15 cm thick. A lime carbonate horizon, 10 to 15 cm thick is often present in shallower soils but is not evident in deeper profiles. Its solum depth averages 58 cm and ranges from 25 to 90 cm. Minor amounts of well drained Eluviated Black soils are included within the Newdale mapping units. They have solum thickness ranging from 75 cm to greater than 1 m. They also have thicker A (combined Ah-Ahe) horizons, 30 to 60 cm and Bt horizons that are 40 cm thick.

The Newdale soils in the study area differ from Erickson soils in being less strongly leached and having less distinct and shallower soil profiles.

Ozerna Series (OZA)

The Ozerna series consists of well drained, Dark Gray Chernozemic soils developed on thin (usually less than 1 m), loamy textured waterlaid sediments, overlying loam to clay loam textured, moderately to strongly calcareous morainal till derived from shales, limestones, and granitic rocks. These loamy surface sediments, usually 15 to 60 cms thick, are separated from the till by a significant, variably thick layer of sand or gravel. The average depth of sediments overlying the till is 66 cm. With this stratified lithology, the surface soils are often droughty because of the low moisture holding capacity of the coarse subsoil layers. Surface runoff is slow; much of the precipitation enters rapidly into the soil. The upper part of the soil is highly permeable but internal drainage may be restricted by the underlying till.

The Ozerna series is characterized by a dark grayish-brown sandy loam Ap and/or Ah horizon (average 18 cm thick), a dark brown Bm or Bt horizon (average 10 cm thick) overlying a coarse sandy Ck horizon and a loam textured IICk horizon.

Penrith Series (PEN)

The Penrith series is characterized by a Humic Luvic Gleysol solum developed on moderately to strongly calcareous, loamy (L-CL) morainal till of limestone, granitic and shale rock origin. These soils are poorly drained and occur in depressional positions of undulating to hummocky landscapes. These soils are ponded for a variable period in the spring and early summer; they usually are free of water in the summer and fall, unless replenished by heavy rains and runoff. Permeability is very slow within the solum and moderately slow in the subsoil. Vegetation consists of sedge and ringed with willow.

The solum of the Penrith series commonly has a moderately to strongly decomposed organic layer, 4 to 8 cm thick, a dark gray to gray Ahe horizon, 6 to 10 cm thick, a light gray, platy Aeg horizon, 6 to 10 cm thick, a dark gray to gray Btg horizon, 35 to 45 cm thick, and a gray transitional BC, 15 to 25 cm thick. In the study area, the A horizon thickness averages 25 cm and ranges from 20 to 30 cm; the average solum depth is 75 cm and ranges from 55 to 95 cm.

Roblin Series (RBN)

The Roblin series consists of poorly drained Humic Luvic Gleysols developed on moderately to strongly calcareous, loam to clay loam textured till derived from shales, limestone, and granitic rock origin. Roblin soils occur in depressional areas of the landscape and because of this, contain sediments and materials deposited by surface waters. Coarse textured gravelly layers are common at the contact with the underlying morainal till. The soils have a loamy surface texture, a clayey Bt and a clay loam parent material. The high clay content in the B horizon is largely pedogenic, having been translocated from the strongly leached and eluviated surface horizon. The soils have very slow surface runoff and moderate to slow permeability. Native vegetation consists of grasses and sedges. Many of these areas have been cultivated.

The solum has a gray to dark gray Ap-Aeg horizon (average 28 cm thick), a dark brown Btg horizon (average 41 cm thick), and an underlying Cg or Ckg horizon. Iron mottling is abundantly present in all horizons.

These soils are easily identified in the landscape by their light gray surface colours. This feature is particularly noticeable in cultivated fields where the strongly eluviated Aeg horizon has been disturbed and brought to the surface by cultivation. These leached layers indicate that much of the ponded water moves down through the soil profile, and is probably added to the groundwater zone. For these reasons, the soils are interpreted as local sites of fast groundwater recharge and are dry by early to mid summer.

St. Lazare Complex (SZR)

The St. Lazare complex is characterized by variable soil development on poorly to nonsorted materials of variable texture and composition deposited at various positions of valley slopes and inclines by mass-wasting or slumping. The materials vary in compostion depending on the nature of the surrounding surface deposits, and in some cases, the underlying bedrock. They include the clays from weathered shale, sand and gravel from adjacent upland fluvial sediments, till-like deposits, or a mixture of all three.

Moderately decomposed organic materials overlying any of the above materials are frequently found in localized depressions or flowages as a result of impeded surface drainage by slump ridges. The presence of well developed sola and a range of parent materials and drainage positions indicates that present slopes have been stable for a considerable period following initial mass-wasting or slumping. Well drained Orthic Dark Gray are the dominant types found on the sandy and glacial till-like material, while Calcareous Black are dominant on the coarser sandy to gravelly materials.

In the lower slope positions of the valley where considerable clay or weathered shale is present, the dominant sola are Solonetzic Dark Gray. In poorly drained depressions and flowage areas, a complex of Rego Humic Gleysol and Terric Mesisols are found on a wide range of mineral soil parent materials.

Topography is complex with hummocky, inclined and ridged (or sawtooth-like) landscape features; slopes range from moderate to very steep. Generally, the steeper slopes occur along upper valley walls. Surface erosion by water is minimal. The shoreline soils, predominantly clayey textured, have not stabilized and continue to erode slowly due to wave impact. Along some portions of the shoreline, considerable ice-transported stony and cobbly ridges have been observed.

Vegetation consists primarily of aspen with some birch, ash, and elm; oak and grasses occur on the drier upper slopes and knolls associated with the sandy and gravelly soils. In the areas affected by ponding and seepage, vegetation varies from sedge and willows on the Rego Humic Gleysols to swamp birch, mosses, and Labrador tea on the organic soils.

The landscape characterized by the St. Lazare Complex (SZR) has been subdivided into 5 mapping unit variants based on soil parent material composition. They are:

SZR1 - The soil parent material is dominantly till-like and similar to the regional upland till. The soil profile is dominantly the Orthic Dark Gray and appears similar in most properties to the Erickson series.

SZR2 - The soil parent material is dominantly sand and gravel and occurs downslope adjacent to areas of Davidson, Marringhurst, or Leary soils. The sola vary from Orthic Dark Gray on sandy deposits to Calcareous Black on sediments having coarser sandy and gravelly textured surface layers.

SZR3 - Soil parent material is dominantly clay textured derived from weathered shale, or is composed of a shallow veneer of clayey till-like material at the surface. Sola developed on these materials have properties similar to those of the Benton series. Sola developed on the thin variable textured (loam to clay) mantle of till-like material are similar to those of the Erickson soils. Some mixing of the loamy till (Erickson) and the clayey (Benton) material has occurred as a result of mass wasting. Shale bedrock with ironstones may be present within one to two meters of the surface.

SZR4 - The soil parent materials are a mixture of the clay, sand, gravel and loamy till. The change in texture may occur abruptly in a horizontal direction or in a vertical direction. The soils of this unit are so variable that soil behavior cannot be predicted on the basis of a single set of soil properties. Individual site locations may be similar to Benton, the Erickson, the Davidson, the Leary, or the Marringhurst soils and predicting the extent of their properties is only possible within a few meters of such individual sites.

SZR5 - The soil parent materials are dominantly a variable depth of moderately decomposed organic material overlying mineral sediments of variable composition. This unit occurs at the base of backslope position of slump ridges and along flowages where coarser materials occur. They are influenced by ponding and seepage for a considerable period of the year. Only the larger units have been delineated on the map, but many smaller units are present. The thickness of the organic layer may vary from 15 cm to greater than 1 meter.

PART 4

USE AND MANAGEMENT INTERPRETATIONS OF SOILS

4.1 INTRODUCTION

This section provides predictions of performance or soil suitability ratings for various uses of soils based on field observations of soil and landscape characteristics, laboratory data and on observations of soil behavior under specified conditions of land use and management. Suitability ratings or interpretations are intended only to serve as guides for planners and managers. Caution, with an understanding of the limitations of the soil map must be exercised when applying suitability ratings to soil map units. The value of any rating or interpretation depends upon the naature and composition of individual map unit delineations which in turn depends on the scale of mapping and intensity of ground truthing employed in the survey.

There are two kinds of mapping units employed in the resurvey of soils in Manitoba.

They are simple mapping units and compound mapping units.

Simple mapping units are usually occupied by one kind of soil series, the properties of which vary within very narrow limits. Often as not they contain minor inclusions of related but unlike soil types. The proportion of such unlike soils tends to increase as the intricacy of soil pattern increases or as the intensity of ground truthing decreases. In any event, such mapping units are usually named after the dominant soil series and any available information about the soil series is applicable to the entire mapping unit. Predictions concerning soil conditions and behavior can be done confidently.

Compound mapping units on the other hand, usually contain significant proportions of two or more unlike soil series. These soils are related geographically but cannot be mapped or delineated separately because of a combination of such factors as the intricacy of soil pattern, map scale and survey effort. In many compound map units, differences in soil types and other characteristics are strongly contrasting. Dominant, subdominant and minor (if strongly contrasting) soil series are identified and the relative proportion that each occupies within a single map delineation is specified. In compound map units, interpretation or suitability ratings can only be applied to that portion of the mapping unit occupied by each identified soil series. In order to apply interpretations to field conditions, it is essential that users determine where each identified soil series in the mapping unit occurs in the landscape. Information contained in the legend accompanying the soil map and other sections of the report is useful for this purpose.

A second type of compound mapping unit is called a soil complex. This compound mapping unit usually contains two or more related but unlike soil series which occur in unspecified proportions. In most cases, the differences in soil profile and other characteristics are not strongly contrasting. Soil complexes are often employed in the mapping of organic soil areas. In such areas ground truthing is limited to such a degree that the proportions of constituent soil series within each map unit delineation is not possible to determine. Complexes are often used in the mapping of beach, outwash, and mass-wasting deposits. Here, soil profile variability occurs over such short intervals of distance that they cannot be shown separately nor can their relative proportions be adequately determined in compound units without excessive and expensive ground truth effort. Interpretations applied to such units cannot be employed with the same degree of confidence as in the case of simple or more specifically defined compound mapping units.

In this section, interpretive soil information is provided for the following land use evaluations:

1. Agriculture
    a) dryland farming capability
    b) irrigation suitability
2. Engineering Uses
3. Recreation Uses

4.2 SOIL CAPABILITY FOR AGRICULTURE

Dryland Agriculture

Soil capability classification for dryland agriculture is based on evaluation of both internal and external soil characteristics that influence soil suitability and limitations for agricultural use. In this classification, mineral soils are grouped into capability classes, subclasses and units based on their limitations for dryland farming, risk of damage when the soils are used and the way they respond to management (Anon., 1965). There are seven capability classes, each of which groups soils together that have the same relative degree of limitation or hazard for agricultural use. The limitation becomes progressively greater from Class 1 to Class 7. The class indicates the general suitability of the soils for agriculture. The first three classes are considered capable of sustained production of common field crops, the fourth is marginal for sustained arable culture, the fifth is suitable only for improved permanent pasture, the sixth is capable of use only for native pasture while the seventh class is for soils and land types considered incapable of use for arable agriculture or permanent pasture.

The definition of the capability classes are as follows:

Class 1

Soils in this class have no important limitations for crop use. The soils have level or gently sloping topography; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils are naturally well supplied with plant nutrients, easily maintained in good tilth and fertility; soils are moderately high to high in productivity for a wide range of cereal and special crops.

Class 2

Soils in this class have moderate limitations that reduce the choice of crops or require moderate conservation practices. The soils have good water holding capacity and are either naturally well supplied with plant nutrients or are highly responsive to inputs of fertilizer. They are moderate to high in productivity for a fairly wide range of crops. The limitations are not severe and good soil management and cropping practices can be applied without serious difficulty.

Class 3

Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations in Class 3 are more severe than those in Class 2 and conservation practices are more difficult to apply and maintain. The limitations affect the timing and ease of tillage, planting and harvesting, the choice of crops and maintenance of conservation practices. The limitations include one or more of the following: moderate climatic limitation, erosion, structure or permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water to plants, stoniness and depth of soil to consolidated bedrock. Under good management, these soils are fair to moderately high in productivity for a fairly wide range of field crops.

Class 4

Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices or both. These soils have such limitations that they are only suited for a few crops, or the yield for a range of crops may be low, or the risk of crop failure is high. The limitations may seriously affect such farm practices as the timing and ease of tillage, planting and harvesting, and the application and maintenance of conservation practices. These soils are low to medium in productivity for a narrow range of crops but may have higher productivity for a specially adapted crop. The limitations include the adverse effects of one or more of the following: climate, accumulative undesirable soil characteristics, low fertility, deficiencies in the storage capacity or release of soil moisture to plants, structure or permeability, salinity, erosion, topography, overflow, wetness, stoniness, and depth of soil to consolidated bedrock.

Class 5

Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. These soils have such serious soil, climatic or other limitations that they are not capable of use for sustained production of annual field crops. However, they may be improved by the use of farm machinery for the production of native or tame species of perennial forage plants. Feasible improvement practices include clearing of bush, cultivation, seeding, fertilizing and water control.

Some soils in Class 5 can be used for cultivated field crops provided unusually intensive management is used. Some of these soils are also adapted to special crops requiring soil conditions unlike those needed by the common crops.

Class 6

Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible. Class 6 soils have some natural sustained grazing capacity for farm animals, but have such serious soil, climatic or other limitations as to make impractical the application of improvement practices that can be carried out on Class 5 soils. Soils may be placed in this class because their physical nature prevents the use of farm machinery, or because the soils are not responsive to improvement practices, or because stock watering facilities are inadequate.

Class 7

Soils in this class have no capability for arable culture or permanent pasture because of extremely severe limitations. Bodies of water too small to delineate on the map are included in this class. These soils may or may not have a high capability for forestry, wildlife and recreation.

Organic soils within the map area are rated for "potential" agricultural capability after the method of Leeson (Leeson et al. 1969). Capability ratings of organic soils for agriculture must recognize that most organic soils have little or no value for agriculture in their native state and their potential is only achieved through reclamation or development implemented with varying degrees of difficulty. Capability class definitions for organic soils are the same as for mineral soils. They are however, identified on maps and tables with the prefix "O".

Soil Capability subclasses are divisions within classes which group soils with similar kinds of limitations and hazards for agricultural use. The various kinds of limitations recognized at the subclass level are defined in Table 5.

Soil Capability units are divisions within the subclass category that groups soils together that will respond similarly to a given management input.

A summary of the soils showing their major characteristics and their interpretive classification for dryland agriculture is presented in Table 6.

TABLE 5

Agricultural Capability Subclass Limitations

C - Adverse climate: This subclass denotes a significant adverse climate for crop production as compared to the "median" climate which is defined as one with sufficiently high growing season temperatures to bring field crops to maturity, and with sufficient precipitation to permit crops to be grown each year on the same land without a serious risk of partial or total crop failures.

D - Undersirable soil structure and/or low permeability: This subclass is used for soils difficult to till, or which absorb water very slowly or in which the depth of rooting zone is restricted by conditions other than a high water table or consolidated bedrock.

E - Erosion: Subclass E includes soils where damage from erosion is a limitation to agricultural use. Damage is assessed on the loss of productivity and on the difficulties in farming land with gullies.

F - Low fertility: This subclass is made up of soils having low fertility that either is correctable with careful management in the use of fertilizers and soil amendments or is difficult to correct in a feasible way. The limitation may be due to lack of available plant nutrients, high acidity or alkalinity, low exchange capacity, high levels of carbonates or presence of toxic compounds.

I - Inundation by streams or lakes: This subclass includes soils subjected to inundation causing crop damage or restricting agricultural use.

L - Coarse wood fragments: In the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.

N - Salinity: Designates soils which are adversely affected by the presence of soluble salts.

P - Stoniness: This subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations. Stony soils are usually less productive than comparable non-stony soils.

R - Consolidated bedrock: This subclass includes soils where the presence of bedrock near the surface restricts their agricultural use. Consolidated bedrock at depths greater than 1 meter from the surface is not considered as a limitation, except on irrigated lands where a greater depth of soil is desirable.

T - Topography: This subclass is made up of soils where topography is a limitation. Both the percent of slope and the pattern or frequency of slopes in different directions are important factors in increasing the cost of farming over that of smooth land, in decreasing the uniformity of growth and maturity of crops, and in increasing the hazard of water erosion.

W - Excess water: Subclass W is made up of soils where excess water other than that brought about by inundation is a limitation to their use for agriculture. Excess water may result from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

X - Cumulative minor adverse characteristics: This subclass is made up of soils having a moderate limitation caused by the cumulative effect of two or more adverse characteristics which singly are not serious enough to affect the class rating.

TABLE 6

Dryland Agriculture Capability and Irrigation Suitability for the Soil Series and Phases

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
ASB	Assiniboine	2I	3SD
BEO /xd2s	Benton	4R	4S
BEO /xf1s	Benton	5T	4ST
BEO /xf3s	Benton	5T	4ST
BKR	Basker	6I	4D
BKRp	Basker	6I	4D
DVD	Davidson	3M	2Sq
ECK	Erickson	2X	3S
ECK /xcxx	Erickson	2T	3S
ECK /xc1x	Erickson	2T	3S
ECK /xc2x	Erickson	2X	3S
ECK /xx2x	Erickson	2X	3S
ECK /xd1x	Erickson	3T	3ST
ECK /xd2x	Erickson	3PT	3ST
ECK /xd3x	Erickson	4P	3ST
ECK /xe1x	Erickson	4T	4T
ECK /xe2x	Erickson	4T	4T
ECK /xx5x	Erickson	6P	4S
FTN	Fortina	5W	4D
FTNp	Fortina	5W	4D
FTNp/xx5x	Fortina	6PW	4D
JAY	Jaymar	3M	2Sq
JAY /xc1x	Jaymar	3M	2Sq
JAY /xc2x	Jaymar	3MT	2Sq
JAY /xd2x	Jaymar	3MT	3TS
KRN	Kerran	4I	4D
LEI /xcxx	Levine	3I	3D
LGD	Longdens	2W	2SD
LRY	Leary	5M	4S
LRY /xcxx	Leary	5M	4S
LRY /xdxx	Leary	5M	4ST
LRY /lexx	Leary	5M	4ST
LRY /xf1x	Leary	5MT	4ST
LRY /xg3x	Leary	6T	4ST
MHC	Marsh Complex	7W	4D
MOW	Mowbray	1	1
MOW /xcxx	Mowbray	2T	2T
MRH	Marringhurst	5M	4S
MRH /xcxx	Marringhurst	5M	4S
MRH /lcxx	Marringhurst	5M	4S

TABLE 6. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
MRH /xc2x	Marringhurst	5M	4S
MRH /xc3x	Marringhurst	5M	4S
MRH /xc4x	Marringhurst	5M	4S
MRH /xdxx	Marringhurst	5M	4S
MRH /xd1x	Marringhurst	5M	4S
MRH /xd3x	Marringhurst	5M	4S
MRH /xd4x	Marringhurst	5MP	4S
MRH /xd5x	Marringhurst	6p	4S
MRH /xexx	Marringhurst	5M	4S
MRH /xfxx	Marringhurst	5MT	4TS
MRH /xf4x	Marringhurst	5PT	4TS
MRH /xf5x	Marringhurst	6P	4TS
NDL /xc1x	Newdale	2T	3S
NDL /xc3x	Newdale	4P	3S
NDL /xd5x	Newdale	6P	4S
NDL /xe2x	Newdale	4T	4T
OZA	Ozerna	2M	2Sq
OZA /xc1x	Ozerna	2MT	3TS
OZA /1c1x	Ozerna	2MT	3TS
OZA /xc2x	Ozerna	2X	2Sq
OZA /xdxx	Ozerna	3T	3TS
PEN	Penrith	5W	4DS
RBN	Roblin	5W	4DS
RBN /xx4x	Roblin	5PW	4DS
SZR1/xc2x	St. Lazare	2X	3S
SZR1/xe1x	St. Lazare	4T	4T
SZR /xe2x	St. Lazare	4T	4T
SZR1/xe3x	St. Lazare	4T	4T
SZR1/xf1x	St. Lazare	4PT	4TS
SZR1/xf2x	St. Lazare	5T	4T
SZR1/xgxx	St. Lazare	6T	4T
SZR1/xg1x	St. Lazare	6T	4T
SZR1/xg2x	St. Lazare	6T	4T
SZR1/xhxx	St. Lazare	7T	4T
SZR1/xh1x	St. Lazare	7T	4T
SZR1/xh2x	St. Lazare	7T	4T
SZR1/xixx	St. Lazare	7T	4T
SZR1/xi1x	St. Lazare	7T	4T
SZR2/xcxx	St. Lazare	5M	4S
SZR2/xdxx	St. Lazare	5M	4S

TABLE 6. AGRICULTURE CAPABILITY CLASSES FOR SOILS

Map Symbol and Phase	Soil Name	Agricultural Capability Class	Irrigation Suitability
SZR2/xd4x	St. Lazare	5MP	4TS
SZR2/xexx	St. Lazare	5M	4TS
SZR2/xe1x	St. Lazare	5M	4TS
SZR2/xe5x	St. Lazare	6P	4TS
SZR2/xfxx	St. Lazare	5MT	4T
SZR2/xf4x	St. Lazare	5PT	4TS
SZR2/xgxx	St. Lazare	6T	4T
SZR2/xhxx	St. Lazare	7T	4T
SZR2/xh2x	St. Lazare	7T	4T
SZR2/xh3x	St. Lazare	7T	4T
SZR2/xixx	St. Lazare	7T	4T
SZR3/xcxx	St. Lazare	3X	4S
SZR3/xc1s	St. Lazare	3DN	4S
SZR3/xd1x	St. Lazare	3DT	4S
SZR3/xd1s	St. Lazare	3DT	4S
SZR3/xexx	St. Lazare	4T	4TS
SZR3/xe1x	St. Lazare	4T	4TS
SZR3/xfxx	St. Lazare	5T	4TS
SZR3/xgxx	St. Lazare	6T	4TS
SZR4/xcxx	St. Lazare	3X	4S
SZR4/xc1x	St. Lazare	3X	4S
SZR4/xexx	St. Lazare	4T	4T
SZR4/xfxx	St. Lazare	5T	4T
SZR4/xf2x	St. Lazare	5T	4T
SZR4/xgxx	St. Lazare	6T	4T
SZR5	St. Lazare	6W	4D
SZR5/xcxx	St. Lazare	6W	4D
SZR5/xexx	St. Lazare	6W	4D
ZZ	Water	7W	4D

4.3 IRRIGATION SUITABILITY

Irrigation suitability of soils is a relative rating to indicate their limitation for sustained production, risk of damage or crop losses, and the ability to maintain favorable soil properties under long term irrigation use. Since the land was mapped on the series-phase basis, a rating for a particular member is provided using pertinent guidelines of Land Classification for Irrigation.

It is emphasized that, at this stage, the properties of the series and phases are rated, not the land in relation to other soil units in the landscape. This rating is a first approximation for general use to be used in conjunction with adjacent soil members, drilling results, and land use evaluation in order to make a final land classification rating determined by evaluating the nature of both the internal and external characteristics (PFRA 1964; Michalyna and Smith 1972). The classification of soils for irrigation suitability consists of two categories: class and subclass.

The suitability class groups soils having the same relative suitability or degree of limitation or hazard for irrigation use. Four classes are utilized grading from 1, which is very good to 4, which is poor. The four classes are:

1 - Very good: These are soils of fine sandy loam to clay loam texture which are well suited for irrigation use. The soils have good water retention capacity, good permeability, low salt content, good drainage and low general gradient of land surface.

2 - Good: These are soils of loamy fine sand to light clay texture which are moderately well suited for irrigation use. Slight limitation to use results from soil factors such as water holding capacity, permeability, depth of material, salt content, topographic factors such as slope and pattern or drainage restrictions arising from surface drainage and depth to water table.

3 - Fair: These are coarse or fine textured soils which are fair to marginally suitable because of some unfavourable characteristics that limit production and cause management problems under irrigation use. Soil, topographic or drainage factors are more restrictive than in Class 2.

4 - Poor: These are soils that are considered poor to unsuitable for irrigation use because of severe drainage problems, impermeable geologic material, salinity, very low water holding capacity, very rapid permeability, topography or a combination of these problems.

The suitability subclass identifies soils with similar kinds of limitations and hazards related to both internal and external soil characteristics. The characteristics are S for soil factors, T for external and topographic factors, and D for drainage or drainability constraints.

S - Soil factors are texture, water holding capacity, hydraulic conductivity (or permeability) uniformity and depth of geological deposits, depth to impervious or slowly permeable layer, level of soluble salts and relative sodium level (SAR).

T - External features are those that

affect the transport of water and any obstructions to operation of equipment or affect adequate size of land. These factors are the type of topography and slope gradients, degree of stones or rock. (The size and shape of field, surface levelling requirement and vegetative covering are not included in the rating at this point, but are considered at the next step of land classification).

D - Drainage is rated on the basis of the implied internal and surface wetness of the soil series and phase at this stage. (For a land classification, the drainability of the land area in conjunction with a satisfactory outlet are considered).

The classification criteria for irrigation are summarized in the Guideline Tables in Appendix D. The soils are evaluated for irrigation suitability in Table 6.

4.4 SOIL SUITABILITY FOR SELECTED ENGINEERING USES

This section provides information which can be used by engineers and land use planners concerned with engineering and related geotechnical aspects of soil. It is intended to supplement the information on the soil map with additional data on engineering properties of soils (see Appendix F for specific Valley features).

The criteria used to evaluate soil suitability for selected engineering and related recreational uses are adopted from guides found in Coen, et al. (1977), and from guidelines developed by the Soil Conservation Service, United States Department of Agriculture (1971), and the Canada Soil Survey Committee (1973).

Definition of Soil Suitability Classes

Evaluation of soil suitability for engineering and recreation uses is based on both internal and external soil characteristics. Four soil suitability classes are used to evaluate both mineral and organic soils and hence, mapping units for selected uses. These ratings express relative degrees of suitability or limitation for potential uses of natural or essentially undisturbed soils. The long term effects of the potential use on the behavior of the soil are considered in the rating.

The four suitability class ratings are defined as follows:

G-Good:	Soils in their present state have few or minor limitations that would affect the proposed use. The limitations would easily be overcome with minimal cost.
F-Fair:	Soils in their present state have one or more moderate limitations that would affect the proposed use. These moderate limitations would be overcome with special construction, design, planning or maintenance.
P-Poor:	Soils in their present state have one or more severe limitations that would severely affect the proposed use. To overcome these severe limitations would require the removal of the limitation or difficult and costly alteration of the soil or special design or intensive maintenance.

V-Very Poor: Soils have one or more features so unfavorable for the proposed use that the limitation is very difficult and expensive to overcome or the soil would require such extreme alteration that the proposed use is economically impractical.

Soil Suitability Subclasses

The subclasses indicate the basic soil properties that singly or in combination with others commonly affect soil suitability for selected engineering properties and recreation uses. The properties and their respective codes are provided in Table 7. These subclass designations serve to identify the kind of limitation or hazard for a particular use.

Example: "Pai" for permanent buildings with basements - indicates a soil rating of poor (P) due to subgrade properties (a) and flooding hazard (i).

Guides for Assessing Soil Suitability

Guides for assessing soil suitability for ten engineering related used are given in the Guideline Tables (Appendix D). These tables provide, as specifically as possible, definitions of the soil properties which result in the specific suitability or degree of limitation. In assessing soil suitability for various engineering uses, the degree of suitability is determined by the most restrictive or most severe rating assigned to any one of the listed soil properties. For example, if the suitability is "Good" for all but one soil property and it is estimated to be "Very Poor", then the overall rating of the soil for that selected use is "Very Poor". Suitability of individual soil properties, if estimated to be "Fair" or "Poor", can be accumulative in their effect for a particular use. Judgement is required to determine whether the severity of the combined effects of several soil properties on suitability for a particular use will result in downgrading an evaluation. This is left to the discretion of the interpreter. It is incorrect to assume that each of the major soil properties influencing a particular use has an equal effect. Class limits established for rating the suitability of individual soil properties take this into account. For a selected use, therefore, only those soil properties which most severely limit that use are specified.

Engineering descriptions and estimated properties significant to engineering for all soils are provided in Table 8. These data, in addition to information contained in other sections of the report have been used to rate the soils according to their suitability for ten selected engineering uses in Table 9. When using these interpretations, consideration must be given to the following assumptions:

1. Interpretations are based on predictions of soil behavior under defined conditions of use and management as specified in the preamble to each of the Guideline Tables (Appendix D).

2. Soil ratings do not include site factors such as nearness to towns and highways, water supply, aesthetic values, etc.

3. Soil ratings are based on natural, undisturbed soil.

4. Soil suitability ratings are usually given for the entire soil, but for some uses, they may be based on the limitations of an individual soil horizon or other earthy layer, because of its overriding importance. Ratings rarely apply to soil depths greater than 1 to 2 meters, but in some kinds of soils, reasonable estimates can be given for soil material at greater depths. It should be noted here that the term "soil" has been used throughout the report in the pedologic sense and differs in concept from that commonly used by engineers.

5. Poor and very poor soil ratings do not imply that a site cannot be changed to remove, correct or modify the soil limitations. The use of soils rated as poor depends on the nature of the limitations, whether or not the soil limitation can be altered successfully and economically, and on the scarcity of good sites.

6. Interpretations of map units do not eliminate the need for on-site evaluation by qualified professionals. Due to the variable nature of soils, and the scale of mapping, small, unmappable inclusions of soils with different properties may be present in an area where a development is planned. The need for or importance of on-site studies depends on the use to be made of the soil and the kinds of soil and soil problems involved.

TABLE 7

Codes utilized to identify limitations in evaluating soil suitability for selected Engineering and Recreational Uses

a	subgrade properties
b	thickness of topsoil
c	coarse fragments on surface
d	depth to bedrock
e	erosion or erodibility
f	susceptibility to frost hazard
g	contamination hazard of groundwater
h	depth to seasonal water table
i	flooding or inundation
j	thickness of slowly permeable material
k	permeability or hydraulic conductivity
l	shrink-swell properties
m	moisture limitations or deficit
n	salinity or sulphate hazard
o	organic matter
p	stoniness
q	depth to sand or gravel
r	rockiness
s	surface texture
t	topographic slope class
u	moist consistence
w	wetness or soil drainage class
z	permafrost

4.5 SOIL SUITABILITY FOR SELECTED RECREATION USES

This section provides interpretations of the soil suitability for recreational development. All types of soil can be used for recreational activities of some kind.

Soils and their properties determine to a large degree, the type and location of recreational facilities. Wet soils are not suitable for campsites, roads, playgrounds or picnic areas. Soils that pond and dry out slowly after heavy rains present problems where intensive use is contemplated. It is difficult to maintain grass cover for playing fields and golf courses on droughty soils. The feasibility of many kinds of outdoor activities are determined by other basic soil properties such as depth to bedrock, stoniness, topography or land pattern, and the ability of the soil to support vegetation of different kinds as related to its natural fertility (see Appendix F for Valley features).

The suitability of the various soil series and phases for selected recreation uses is shown in Table 10 according to four classes, Good, Fair, Poor and Very Poor defined previously in the section on Engineering Uses. Subclasses are employed to identify the kind of limitation or hazard for a particular use. An explanation of subclass symbols are provided in Table 7.

The guidelines for various recreation uses are presented in the Guideline Tables (Appendix D).

TABLE 8

Estimated Engineering Properties of the Soils

Map Sym-bol	Soil Series Name	Depth from Surface cm	Textural Classification			% Passing Sieve			Permeability (cm/hr)	Reaction (pH)	Elec-trical Conduc-tivity (mS/cm)	Sulphate Hazard	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
ASB	Assiniboine	0-40	C-SiC	CH	A-7-6	100	100	90-100	0.5-1.5	7.0-7.4	<0.5	low	high	subject to flood; 1 m
		40-100	strat.SiC-C	CH	A-7-6	100	100	90-100	.15-1.5	7.6-7.8	<0.5	low	high	
BEO	Benton	0-30	C	CH	A-7-6	100	100	90-100	<.15	6.8-7.4	<2	low	high	>2 m
		30-70	C	CH	A-7-6	95-100	90-100	85-95	<.01	7.2-7.6	4-8	high	high	
		70-100	C(Sh)	CH	A-7-6	60-75	55-70	55-70	<.01	5.5	>8	high	high	
BKR	Basker	30-120	L-CL	CL	A-6,A-7-6	100	75-95	80-90	.5-5	7.8-8.2	var.	var.	mod.	at surface -flooding
DVD	Davidson	20-70	FSL-SCL	SM to SC	A-4	100	70-90	35-55	5-15	6.8-7.4	<0.5	low	low	>2 m
		70-120	LFS-FS	SM	A-2-4	100	60-80	25-45	>15	7.8-8.2	<0.5	low	low	
ECK	Erickson	25-70	CL-C	CL to CH	A-7-6	85-95	85-95	75-90	.5-1.5	7.0-7.6	<0.5	low	high	>2 m
		70-120	L-CL	CL	A-6	85-95	80-90	60-75	.5-5	7.8-8.2	<1.0	low	mod.	
FTN	Fortina	0-25	LS	SP	A-2-4	100	90-100	10-35	.5-5	7.4-7.8	<0.5	low	low	at or near surface
		22-100	S & Gr	GP to SP	A-1	35-60	-	<5	>15	7.6-8.2	<1.0	low	low	
JAY	Jaymar	0-40	SL-L	ML to CL	A-6	85-95	75-90	35-70	5-15	7.3-7.8	<0.5	low	low to mod.	>2 m
		40-85	GrS	GM to SM	A-2,A-1	Var.	<10	<5	>15	7.8-8.2	<0.5	low	low	
		85-100	L-CL	CL	A-6	80-90	60-80	50-70	0.5-5	7.8-8.2	<0.5	low	mod.	
LEI	Levine	25-60	CL	CL	A-6,A-7-6	100	90-100	80-95	<.5	7.4-7.8	var <4	var.	mod.	subject to flood; 1 m
		60-120	L-CL	CL	A-6	100	90-100	80-95	.15-5	7.8-8.2	var <4	var.	mod.	
LGD	Longdens	0-40	SL-L	ML to CL	A-6	85-95	75-90	35-70	1.5-5	6.5-7.2	<0.5	low	mod.	
		40-90	LS-GrS	GM to SM	A-2,A-1	Var.	<10	<5	>15	7.4-8.0	<.5	low	low	0.9 m, perched
		90-100	L-CL	CL	A-6	80-90	60-80	50-70	.15-5	7.8-8.2	0.5	low	mod.	
LRY	Leary	0-20	SL	SM	A-2-4	75-95	50-70	20-40	15-50	6.8-7.4	<0.5	none	low	>2 m
		20-100	S-Gr	GW	A-1	30-65		<5	>50	7.4-8.2	<0.5	none	low	
MOW	Mowbray	0-30	L	ML, CL	A-4,A-6	100	100	80-95	1.5-5	7.2-7.6	<0.5	low	mod.	>2 m
		30-100	Strat. SiL-SiCL	ML, CL	A-4, A-6	100	100	80-95	1.5-5	7.8-8.2	<0.5	low	mod.	
MRH	Marring-hurst	0-20	LFS-FSL	SM to SP	A-2-4	100	90-100	10-35	5-15	7.4-7.8	<0.5	none	low	>2 m
		20-50	GrLS-GrS	GP to SP	A-1	35-60	-	<5	>15	7.8-8.2	<0.5	none	low	
		50-100	S & Gr	GP to SP	A-1	35-60	-	<5	>15	7.8-8.2	<0.5	none	low	
NDL	Newdale	25-65	L-CL	CL	A-6	85-95	75-90	60-75	.15-1.5	6.6-7.4	<0.5	low	mod.	>2 m
		65-120	L-CL	CL	A-6	85-95	75-90	60-75	.15-5	7.8-8.2	<1.0	low	mod.	

Table 8 continued

Map Symbol	Soil Series Name	Depth from Surface cm	Textural Classification			% Passing Sieve			Permeability (cm/hr)	Reaction (pH)	Electrical Conductivity (mS/cm)	Sulphate Hazard	Shrink-Swell Potential	Depth to Seasonal Water Table (m)
			USDA	Unified	AASHO	No. 10 2.0 mm	No. 40 0.42 mm	No. 200 0.074 mm						
OZA	Ozerna	0-20	FSL-L	SM	A-2-4,A-4	100	55-75	15-35	5-15	6.6-7.2	<0.5	low	low	>2 m
		20-70	LS	SW	A-2	80-100	60-80	25-45	15-50	7.2-7.6	<0.5	low	low	
		70-100	L-CL	CL	A-6	85-95	75-90	55-75	0.5-5	7.8-8.2	<1.0	low	mod.	
PEN	Penrith	30-85	C	CH	A-7-6	100	95-100	75-95	<.15	6.6-7.4	<.5	low	high	at surface
		85-120	L-CL	CL	A-6	85-95	75-90	60-75	.15-5	7.8-8.2	<.5	low	mod.	
RBN	Roblin	0-40	L	CL	A-6	95-100	85-100	60-80	.15-5	6.6-7.4	<0.5	low	mod.	at surface
		40-80	C	CH	A-7-6	100	85-100	70-95	<.15	6.6-7.4	<0.5	low	high	
		80-100	L-CL	CL	A-6	85-95	75-90	60-75	.15-5	7.6-8.2	<0.5	low	mod.	
SZR	St.Lazare Complex (dom.)	1 30-70	CL-C	CH	A-7-6	85-95	85-95	75-90	0.5-1.5	7.0-7.6	<0.5	low	high	>2 m
		70-100	L-CL	CL	A-6	85-95	80-90	60-75	.15-5	7.8-8.2	<0.5	low	mod.	
		2 20-100	S-Gr	GW	A-1	30-65		<5	>50	7.4-8.2	<0.5	low	low	>2 m
		3 40-100	C(Sh)	CH	A-7-6				<.05	5.5-7.4	>4	high	high	>2 m
		4 variable							var.	var.	var.	var.	var.	>2 m
		5 surface (var.)	Oh	Pt										at or near surface, seepage
		mineral	var.	var.	var.								var.	

TABLE 9. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
ASB	Assiniboine	Psb	Va	Pal	Vai	Pai	Pi	Pi	Ps	Vi	Vk
BEO /xd2s	Benton	Ps	Va	Pal	Pad	Paf	Ps	G	Ps	Ft	Vk
BEO /xf1s	Benton	Vt	Va	Pal	Pat	Paf	Ps	Pt	Pst	Pt	Vk
BEO /xf3s	Benton	Vt	Va	Pal	Pat	Paf	Psp	Pt	Pst	Pt	Vk
BKR	Basker	Vwi	Va	Vh	Vi	Vi	Vi	Viw	Pw	Vi	Vi
BKRp	Basker	Vwi	Va	Vh	Viw	Vi	Vi	Viw	Pw	Vi	Vi
DVD	Davidson	Ps	Pa	G	G	G	Vsk	Vk	Vs	Vk	Gg
ECK	Erickson	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fk	Fk
ECK /xcxx	Erickson	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
ECK /xc1x	Erickson	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
ECK /xc2x	Erickson	Fsp	Va	Fa	Fap	Fa	Fs	G	Fsp	Fkt	Fk
ECK /xx2x	Erickson	Fsp	Va	Fa	Fap	Fa	Fsp	G	Fsp	Fk	Fk
ECK /xd1x	Erickson	Fst	Va	Fa	Fa	Fa	Fs	G	Fs	Pt	Fk
ECK /xd2x	Erickson	Ftp	Va	Fa	Fap	Fa	Fs	G	Fsp	Pt	Fk
ECK /xd3x	Erickson	Pp	Va	Fap	Pp	Fap	Fsp	G	Pp	Pt	Fk
ECK /xe1x	Erickson	Pt	Va	Fa	Fat	Fat	Fs	Ft	Fst	Pt	Fkt
ECK /xe2x	Erickson	Pt	Va	Fa	Fat	Fat	Fsp	Ft	Fst	Vt	Fkt
ECK /xx5x	Erickson	Vp	Vap	Vp	Vp	Vp	Vp	G	Vsp	Vkt	Vp
FTN	Fortina	Ps	Pw	Vh	Pw	Pw	Vw	Vkw	Vsw	Vhk	Vh
FTNp	Fortina	Ps	Pw	Vha	Vw	Pw	Vw	Vkw	Vsw	Vk	Vh
FTNp/xx5x	Fortina	Vp	Pw	Vwp	Vwp	Vp	Vw	Vkw	Vpw	Vk	Vh
JAY	Jaymar	Fbs	Va	Fa	Fa	Fa	Fs	Pkg	Fs	Fk	Fkg
JAY /xc1x	Jaymar	Fbs	Va	Fa	Fa	Fa	Fs	Pkg	Fs	Fkt	Fkg
JAY /xc2x	Jaymar	Fbp	Va	Fa	Fap	Fa	Fsp	Pkg	Fsp	Fkt	Fkg
JAY /xd2x	Jaymar	Ftp	Va	Fa	Fap	Fa	Fap	Pkg	Fsp	Pt	Fkg
KRN	Kerran	Pis	Va	Paw	Vi	Vi	Vih	Vih	Psw	Vi	Vih
LEI /xcxx	Levine	Fs	Va	Faw	Piw	Pfi	Pi	Pi	Fs	Vi	Vh
LGD	Longdens	Fb	Va	Fa	Pw	Faw	Fs	Pk	Fs	Vk	Fkh
LRY	Leary	Ps	G	G	G	G	Vsk	Vk	Vs	Vk	Gg
LRY /xcxx	Leary	Ps	G	G	G	G	Vsk	Vk	Vs	Vk	Gg

TABLE 9. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
LRY /xdxx	Leary	Ps	G	G	G	G	Vsk	Vk	Vs	Vk	Gg
LRY /lexx	Leary	Pst	G	G	Ft	Ft	Vsk	Vk	Vs	Vk	Ftg
LRY /xflx	Leary	Vt	G	Ft	Pt	Pt	Vsk	Vk	Vs	Vk	Ptg
LRY /xg3x	Leary	Vt	G	Pt	Vt	Vt	Vsk	Vk	Vs	Vk	Vtg
MHC	Marsh Complex	Vw	Va	Vw	Vwa	Vwa	Vw	Vw	Vw	Vhi	Vhi
MOW	Mowbray	Pb	Va	Fa	Fa	Fa	Fis	Fi	Fs	Fa	Fk
MOW /xcxx	Mowbray	Pb	Va	Fa	Fa	Fa	Fis	Fi	Fs	Fat	Fk
MRH	Marringhurst	Psb	G	G	G	G	Vsk	Vk	Vs	Vk	Gg
MRH /xcxx	Marringhurst	Psb	G	G	G	G	Vsk	Vk	Vs	Vk	Gg
MRH /lcxx	Marringhurst	Psb	G	G	G	G	Vsk	Vk	Vs	Vk	Gg
MRH /xc2x	Marringhurst	Psb	G	G	Fp	G	Vsk	Vk	Vs	Vk	Gg
MRH /xc3x	Marringhurst	Psb	G	G	Pp	Fp	Vsk	Vk	Vs	Vk	Gg
MRH /xc4x	Marringhurst	Psb	Pp	Pp	Pp	Pp	Vsk	Vk	Vs	Vk	Gg
MRH /xdxx	Marringhurst	Pbt	G	G	G	G	Vsk	Vk	Vs	Vk	Gg
MRH /xdlx	Marringhurst	Pbt	G	G	G	G	Vsk	Vk	Vs	Vk	Gg
MRH /xd3x	Marringhurst	Pbt	G	Fp	Pp	Fp	Vsk	Vk	Vs	Vk	Gg
MRH /xd4x	Marringhurst	Pp	Pp	Pp	Pp	Pp	Vsk	Vk	Vs	Vk	Gg
MRH /xd5x	Marringhurst	Vp	Vp	Vp	Vp	Vp	Vsk	Vk	Vsp	Vk	Gg
MRH /xexx	Marringhurst	Pst	G	G	Ft	Ft	Vsk	Vk	Vst	Vkt	Fg
MRH /xfxx	Marringhurst	Vt	G	Ft	Pt	Pt	Vsk	Vk	Vst	Vkt	Ptg
MRH /xf4x	Marringhurst	Vt	Pp	Pp	Ptp	Ppt	Vsk	Vk	Vst	Vkt	Ptg
MRH /xf5x	Marringhurst	Vpt	Vp	Vp	Vp	Vp	Vsk	Vk	Vst	Vkt	Ptg
NDL /xclx	Newdale	Fs	Va	Fa	Fa	Fa	Fs	G	Fs	Fkt	Fk
NDL /xc3x	Newdale	Pp	Va	Fap	Pp	Fap	Pp	G	Pp	Fkt	Fk
NDL /xd5x	Newdale	Vp	Va	Vp	Vp	Vp	Vp	G	Vp	Vp	Fk
NDL /xe2x	Newdale	Pt	Va	Fa	Ftp	Fat	Fsp	Ft	Fsp	Vt	Fkt
OZA	Ozerna	Fb	Va	Fa	Fa	Fa	Fs	Pk	Fs	Fk	Fkg
OZA /xclx	Ozerna	Fb	Va	Fa	Fa	Fa	Fs	Pkg	Fs	Fkt	Fkg
OZA /lclx	Ozerna	Pb	Va	Fa	Fa	Fa	Fs	Pkg	Fs	Fkt	Fkg
OZA /xc2x	Ozerna	Fp	Va	Fa	Fa	Fa	Fs	Pkg	Fsp	Fkt	Fkg

TABLE 9. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol an Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
OZA /xdxx	Ozerna	Ft	Va	Fa	Fa	Fa	Fs	Pkg	Fs	Pt	Fkg
PEN	Penrith	Fsb	Va	Paf	Pwa	Pwf	Vw	Pw	Pws	G	Vkh
RBN	Roblin	Fsb	Va	Paf	Pwa	Pwf	Vw	Pw	Pws	G	Vkh
RBN /xx4x	Roblin	Pp	Va	Paf	Pwa	Pwf	Vw	Pw	Pwp	Pp	Vkh
SZR1/xc2x	St. Lazare	Fsb	Va	Fa	Fa	Fa	Fs	P	Fs	Pt	Fk
SZR1/xe1x	St. Lazare	Pt	Va	Fa	Vt	Pt	Pt	Pt	Fs	Vt	Fkt
SZR /xe2x	St. Lazare	Pt	Va	Fa	Vt	Pt	Pt	Pt	Fs	Vt	Fkt
SZR1/xe3x	St. Lazare	Ptp	Va	Fa	Vt	Pt	Ppt	Pt	Fs	Vt	Fkt
SZR1/xf1x	St. Lazare	Vt	Va	Fat	Vt	Vt	Pt	Pt	Fs	Vt	Pt
SZR1/xf2x	St. Lazare	Vt	Va	Fat	Vt	Vt	Pt	Pt	Fsp	Vt	Pt
SZR1/xgxx	St. Lazare	Vt	Va	Fat	Vt	Vt	Vt	Vt	Pt	Vt	Pt
SZR1/xg1x	St. Lazare	Vt	Va	Fat	Vt	Vt	Vt	Vt	Pt	Vt	Pt
SZR1/xg2x	St. Lazare	Vt	Va	Pt	Vt	Vt	Vt	Vt	Pt	Vt	Vt
SZR1/xhxx	St. Lazare	Vt	Va	Vt	Vt	Vt	Vt	Vt	Pt	Vt	Vt
SZR1/xh1x	St. Lazare	Vt	Va	Vt	Vt	Vt	Vt	Vt	Pt	Vt	Vt
SZR1/xh2x	St. Lazare	Vt	Va	Vt	Vt	Vt	Vt	Vt	Pt	Vt	Vt
SZR1/xixx	St. Lazare	Vt	Va	Vt	Vt	Vt	Vt	Vt	Pt	Vt	Vt
SZR1/xi1x	St. Lazare	Vt	Va	Vt	Vt	Vt	Vt	Vt	Pt	Vt	Vt
SZR2/xcxx	St. Lazare	Psb	G	G	Ft	G	Vsk	Vk	Vs	Vk	Vt
SZR2/xdxx	St. Lazare	Pbt	G	G	Ft	Ft	Vsk	Vk	Vs	Vk	Gg
SZR2/xd4x	St. Lazare	Ppt	G	Pp	Ft	Pp	Vsk	Vk	Vs	Vk	Gg
SZR2/xexx	St. Lazare	Pst	G	G	Pt	Pt	Vsk	Vk	Vs	Vkt	Ftg
SZR2/xe1x	St. Lazare	Pst	G	G	Pt	Pt	Vsk	Vk	Vs	Vkt	Ftg
SZR2/xe5x	St. Lazare	Vp	Vp	Vp	Vp	Vp	Vsk	Vk	Vsp	Vkt	Vp
SZR2/xfxx	St. Lazare	Vt	G	Ft	Vt	Vt	Vsk	Vkt	Vs	Vkt	Ptg
SZR2/xf4x	St. Lazare	Vt	G	Fpt	Vt	Vt	Vsk	Vkt	Vs	Vkt	Ptg
SZR2/xgxx	St. Lazare	Vt	G	Pt	Vt	Vt	Vsk	Vkt	Vs	Vkt	Vtg
SZR2/xhxx	St. Lazare	Vt	G	Pt	Vt	Vt	Vsk	Vkt	Vs	Vkt	Vtg
SZR2/xh2x	St. Lazare	Vt	G	Pt	Vt	Vt	Vsk	Vkt	Vs	Vkt	Vtg
SZR2/xh3x	St. Lazare	Vt	G	Pt	Vt	Vt	Vsk	Vkt	Vs	Vkt	Vtg

TABLE 9. SUITABILITY RATINGS OF SOILS FOR SELECTED ENGINEERING USES

Map Symbol and Phase	Soil Name	Top Soil	Sand & Gravel	Road Fill	Permanent Bldgs. With Basements	Local Roads and Streets	Sanitary Trench	Landfill Area	Cover Material	Sewage Lagoons	Septic Fields
SZR2/xixx	St. Lazare	Vt	G	Vt	Vt	Vt	Vsk	Vkt	Vs	Vkt	Vtg
SZR3/xcxx	St. Lazare	Ps	Va	Pa	Pa	Paf	Fs	Pk	Ps	Pk	Pk
SZR3/xcls	St. Lazare	Ps	Va	Pal	Pa	Paf	Fs	Pk	Ps	Ft	Pk
SZR3/xdlx	St. Lazare	Ps	Va	Pal	Pat	Paf	Fs	Pt	Ps	Pt	Pk
SZR3/xdls	St. Lazare	Ps	Va	Pal	Pat	Paf	Fs	Pt	Ps	Pt	Pk
SZR3/xexx	St. Lazare	Pst	Va	Pal	Pat	Paf	Pt	Pt	Ps	Vt	Pk
SZR3/xelx	St. Lazare	Pst	Va	Pal	Pat	Paf	Pt	Pt	Ps	Vt	Pk
SZR3/xfxx	St. Lazare	Vt	Va	Pal	Vt	Vt	Pt	Vt	Ps	Vt	Pkt
SZR3/xgxx	St. Lazare	Vt	Va	Pal	Vt	Vt	Vt	Vt	Pst	Vt	Vt
SZR4/xcxx	St. Lazare	Ps	Va	Paf	Ft	Paf	Fs	Pk	Ps	Pk	Pk
SZR4/xclx	St. Lazare	Ps	Va	Paf	Ft	Paf	Fs	Pk	Ps	Pk	Pk
SZR4/xexx	St. Lazare	Pt	Va	Paf	Vt	Paf	Pt	Pt	Ps	Vt	Pk
SZR4/xfxx	St. Lazare	Vt	Va	Paf	Vt	Vt	Pt	Vt	Ps	Vt	Pkt
SZR4/xf2x	St. Lazare	Vt	Va	Paf	Vt	Vt	Pt	Vt	Ps	Vt	Pkt
SZR4/xgxx	St. Lazare	Vt	Va	Pat	Vt	Vt	Vt	Vt	Pst	Vt	Vt
SZR5	St. Lazare	Vw	Va	Vw	Vw	Vw	Vwh	Vw	Vw	Vah	Vh
SZR5/xcxx	St. Lazare	Vw	Va	Vw	Vw	Vw	Vwh	Vw	Vw	Vah	Vh
SZR5/xexx	St. Lazare	Vw	Va	Vw	Vw	Vw	Vwh	Vw	Vw	Vah	Vh
ZZ	Water	Vw	Va	Vw	Vw	Vw	Vw	Vw	Vw	Vw	Vh

Note: 1. The SZR1 to SZR5 map unit ratings have been adjusted to account for the potential risk to hillside slippage.

2. The need for, or importance of on-site studies depend on the use to be made of the soil and the kinds of soil and soil problems involved; studies should include hydrological and geological investigations.

TABLE 10. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
ASB	Assiniboine	Psk	Ps	Psi	Ps	Pai
BEO /xd2s	Benton	Pst	Ps	Ps	Ps	Paf
BEO /xf1s	Benton	Vt	Ps	Pst	Ps	Pat
BEO /xf3s	Benton	Vt	Pps	Pst	Ps	Pat
BKR	Basker	Pi	Vwi	Vwi	Pw	Vh
BKRp	Basker	Vsi	Vwi	Vwi	Vs	Vh
DVD	Davidson	Fsm	Fsm	Fs	G	G
ECK	Erickson	Fst	Fs	Fs	Fs	Fa
ECK /xcxx	Erickson	Fst	Fs	Fs	Fs	Fa
ECK /xc1x	Erickson	Fst	Fs	Fs	Fs	Fa
ECK /xc2x	Erickson	Fst	Fs	Fsp	Fs	Fa
ECK /xx2x	Erickson	Fsp	Fs	Fsp	Fs	Fa
ECK /xd1x	Erickson	Pt	Fs	Fs	Fs	Fa
ECK /xd2x	Erickson	Pt	Fs	Fsp	Fs	Fa
ECK /xd3x	Erickson	Ptp	Pp	Pp	Fsp	Pp
ECK /xe1x	Erickson	Vt	Fst	Fst	Fs	Fat
ECK /xe2x	Erickson	Vt	Fst	Fst	Fs	Fat
ECK /xx5x	Erickson	Vpt	Pmp	Pp	Vp	Vp
FTN	Fortina	Vw	Vw	Vw	Pw	Vh
FTNp	Fortina	Vsw	Vw	Vw	Vsw	Vha
FTNp/xx5x	Fortina	Vsw	Vwp	Fs	Vpw	Vha
JAY	Jaymar	Fsq	Fs	Fs	Fs	Fa
JAY /xc1x	Jaymar	Fst	Fs	Fs	Fs	Fa
JAY /xc2x	Jaymar	Fst	Fs	Fsp	Fs	Fa
JAY /xd2x	Jaymar	Pt	Fs	Fsp	Fs	Fa
KRN	Kerran	Pis	Piw	Piw	Vpw	Vi
LEI /xcxx	Levine	Fsi	Fsi	Pi	Fs	Pfi
LGD	Longdens	Fsw	Fsw	Fsw	Fsw	Faw
LRY	Leary	Pqm	Pm	Fs	G	G
LRY /xcxx	Leary	Pqm	Pm	Fs	G	G
LRY /xdxx	Leary	Pmt	Pm	Fs	G	G
LRY /1exx	Leary	Vt	Pm	Fst	G	Ft
LRY /xf1x	Leary	Vt	Pmt	Pt	Ft	Pt
LRY /xg3x	Leary	Vt	Vt	Vt	Pt	Vt
MHC	Marsh Complex	Vw	Vw	Vw	Vw	Vh
MOW	Mowbray	Fs	Fs	Fs	Fs	Fs
MOW /xcxx	Mowbray	Fst	Fs	Fs	Fs	Fs
MRH	Marringhurst	Pmq	Pm	G	G	G
MRH /xcxx	Marringhurst	Pmq	Pm	G	G	G
MRH /1cxx	Marringhurst	Pmq	Pm	G	G	G

TABLE 10. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
MRH /xc2x	Marringhurst	Pmq	Pm	Fp	G	G
MRH /xc3x	Marringhurst	Pmq	Pm	Pp	Fp	Fp
MRH /xc4x	Marringhurst	Pmp	Pm	Pp	Pp	Pp
MRH /xdxx	Marringhurst	Pmt	Pm	G	G	G
MRH /xd1x	Marringhurst	Pmt	Pm	G	G	G
MRH /xd3x	Marringhurst	Pmt	Pm	Pp	Fp	Fp
MRH /xd4x	Marringhurst	Pmt	Pm	Pp	Pp	Pp
MRH /xd5x	Marringhurst	Vp	Vp	Vp	Vp	Vp
MRH /xexx	Marringhurst	Vt	Pm	Ft	G	Ft
MRH /xfxx	Marringhurst	Vt	Pmt	Pt	Ft	Pt
MRH /xf4x	Marringhurst	Vt	Pmt	Ppt	Ft	Ptp
MRH /xf5x	Marringhurst	Vtp	Vtp	Vp	Pp	Vp
NDL /xc1x	Newdale	Fst	Fs	Fs	Fs	Fa
NDL /xc3x	Newdale	Pp	Fs	Pp	Fs	Fap
NDL /xd5x	Newdale	Vp	Vp	Vp	Fsp	Vp
NDL /xe2x	Newdale	Vt	Fst	Fst	Fs	Fat
OZA	Ozerna	Fs	Fs	Fs	Fs	Fs
OZA /xc1x	Ozerna	Fst	Fs	Fs	Fs	Fs
OZA /1c1x	Ozerna	Fst	Fs	Fs	Fs	Fs
OZA /xc2x	Ozerna	Fat	Fs	Fsp	Fs	Fs
OZA /xdxx	Ozerna	Pt	Fs	Fs	Fs	Fs
PEN	Penrith	Vw	Vw	Vw	Pw	Vh
RBN	Roblin	Vw	Vw	Vw	Pw	Vh
RBN /xx4x	Roblin	Vw	Vw	Vw	Pwp	Vh
SZR1/xc2x	St. Lazare	Fst	Fs	Fsp	Fs	Fs
SZR1/xe1x	St. Lazare	Vt	Fst	Fst	Fs	Pt
SZR /xe2x	St. Lazare	Vt	Fst	Fst	Fs	Pt
SZR1/xe3x	St. Lazare	Vt	Fst	Pp	Fs	Pt
SZR1/xf1x	St. Lazare	Vt	Pt	Pt	Fsp	Vt
SZR1/xf2x	St. Lazare	Vt	Pt	Pt	Fst	Vt
SZR1/xgxx	St. Lazare	Vt	Vt	Vt	Fst	Vt
SZR1/xg1x	St. Lazare	Vt	Vt	Vt	Fst	Vt
SZR1/xg2x	St. Lazare	Vt	Vt	Vt	Pt	Vt
SZR1/xhxx	St. Lazare	Vt	Vt	Vt	Vt	Vt
SZR1/xh1x	St. Lazare	Vt	Vt	Vt	Vt	Vt
SZR1/xh2x	St. Lazare	Vt	Vt	Vt	Vt	Vt
SZR1/xixx	St. Lazare	Vt	Vt	Vt	Vt	Vt
SZR1/xi1x	St. Lazare	Vt	Vt	Vt	Vt	Vt
SZR2/xcxx	St. Lazare	Pmq	Pm	G	G	G
SZR2/xdxx	St. Lazare	Pmt	Pm	G	G	Ft

TABLE 10. SUITABILITY RATINGS OF SOILS FOR RECREATIONAL USES

Map Symbol and Phase	Soil Name	Play Ground	Picnic Area	Camp Area	Path And Trails	Permanent Bldgs. Without Basements
SZR2/xd4x	St. Lazare	Pmt	Pm	Pp	Pp	Pp
SZR2/xexx	St. Lazare	Vt	Pm	Ft	G	Pt
SZR2/xelx	St. Lazare	Vt	Pm	Ft	G	Pt
SZR2/xe5x	St. Lazare	Vpt	Pmp	Pp	Vp	Vp
SZR2/xfxx	St. Lazare	Vt	Pmt	Pt	Ft	Vt
SZR2/xf4x	St. Lazare	Vt	Pmt	Ptp	Pp	Vt
SZR2/xgxx	St. Lazare	Vt	Vt	Vt	Pt	Vt
SZR2/xhxx	St. Lazare	Vt	Vt	Vt	Pt	Vt
SZR2/xh2x	St. Lazare	Vt	Vt	Vt	Pt	Vt
SZR2/xh3x	St. Lazare	Vt	Vt	Vt	Pt	Vt
SZR2/xixx	St. Lazare	Vt	Vt	Vt	Vt	Vt
SZR3/xcxx	St. Lazare	Ps	Ps	Ps	Ps	Pa
SZR3/xcls	St. Lazare	Ps	Ps	Ps	Ps	Pa
SZR3/xdlx	St. Lazare	Pst	Ps	Ps	Ps	Pa
SZR3/xdls	St. Lazare	Pst	Ps	Ps	Ps	Pa
SZR3/xexx	St. Lazare	Vt	Ps	Ps	Ps	Pat
SZR3/xelx	St. Lazare	Vt	Ps	Ps	Ps	Pat
SZR3/xfxx	St. Lazare	Vt	Pst	Pst	Ps	Vt
SZR3/xgxx	St. Lazare	Vt	Vt	Pst	Pst	Vt
SZR4/xcxx	St. Lazare	Ps	Ps	Ps	Ps	Pa
SZR4/xclx	St. Lazare	Ps	Ps	Ps	Ps	Pa
SZR4/xexx	St. Lazare	Vt	Fst	Ps	Ps	Pat
SZR4/xfxx	St. Lazare	Vt	Pt	Pst	Ps	Vt
SZR4/xf2x	St. Lazare	Vt	Pt	Pst	Ps	Vt
SZR4/xgxx	St. Lazare	Vt	Vt	Vt	Pst	Vt
SZR5	St. Lazare	Vw	Vw	Vw	Vw	Vw
SZR5/xcxx	St. Lazare	Vw	Vw	Vw	Vw	Vw
SZR5/xexx	St. Lazare	Vw	Vw	Vw	Vw	Vw
ZZ	Water	Vw	Vw	Vw	Vw	Vw

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Appendix A

GLOSSARY

AASHO classification (soil engineering) - The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acid soil - A soil having a pH less than 7. See pH and Reaction, soil.

Alkaline soil - A soil having a pH greater than 7. See Reaction, soil.

Alluvium - A general term for all deposits of rivers and streams.

Arable soil - Soil suitable for plowing and cultivation.

Association - A sequence of soils of about the same age, derived from similar parent material, and occuring under similar climatic conditions but showing different characteristics due to variations in relief and in drainage.

1/3 Atmosphere Moisture - The moisture percentage on dry weight basis of a soil sample that has been air dried, screened, saturated and subjected to a soil moisture tension of 345 cm of water through a permeable membrane for a period of 48 hours. It approximates the soil moisture retention capacity.

Available nutrient - That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Available soil moisture - The portion of water in a soil that can be readily absorbed by plant roots: generally considered to be that water held in the soil up to approximately 15 atmospheres pressure.

Bearing capacity - Capacity of soil (in moist to wet conditions) to support loads such as buildings, people, vehicles, and animals.

Bedrock - The solid rock that underlies soil and regolith or that is exposed at the surface.

Boulders - Stones which are larger than 60 cm in diameter.

Bulk density - The weight of oven dry soil (105 degrees C) divided by its volume at field moisture conditions, expressed in grams per cubic centimeter.

Buried soil - Soil covered by an alluvial, loessial, or other deposit, usually to a depth greater than the thickness of the solum.

Calcareous soil - Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

Calcium Carbonate Equivalent - Refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate contents of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
v. strongly calcareous	26-40%
extremely calcareous	>40%

Capillary fringe - A zone of essentially saturated soil just above the water table. The size distribution of the pores determines the extent and degree of the capillary fringe.

Carbon-nitrogen ratio (C/N ratio) - The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.

Cation Exchange Capacity (**CEC**) - A measure of the total amount of exchangeable cations that can be held by a soil. Expressed in milliequivalents per 100g of soil.

Clay - As a soil separate, the mineral soil particles less than 0.002 mm in diameter: usually consisting largely of clay minerals. As a soil textural class, soil materials that contain 40 or more percent clay, less than 45 percent sand and less than 40 percent silt.

Cobbles - Rock fragments 8 to 25 cm in diameter.

Color - Soil colors are compared with a Munsell color chart. The Munsell system specifies the relative degrees of the three simple variables of color: hue, value and chroma. For example: 10YR 6/4 means a hue of 10YR, a value of 6, and a chroma of 4.

Complex (**soil**) - A mapping unit used in detailed and reconnaissance soil surveys where two or more soil series that are so intimately intermixed in an area that it is impractical to separate them at the scale of mapping used.

Concretions - Hard grains, pellets or nodules from concentration of compounds in the soil that cement soil grains together.

Conductivity, electrical - A physical quantity that measures the readiness with which a medium (irrigation water and soil extracts) transmits electricity. It expresses the concentration of salt in terms of the conductance (reciprocal of the electric resistance in ohms) in millisiemens per cm.

Consistence (**soil**) - The mutual attraction of the particles in a soil mass, or their resistence to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented.

Consumptive use factor (**CU**) - The ratio of consumptive use of water by a crop to potential evapotranspiration. and transpiration. An actively growing crop that completely covers the soil over a large area and that has an ample supply of readily available soil water has a consumptive use factor of 1.0.

Consumptive use of water - The sum of the depths of water transpired by the plants and evaporated from the soil surface and from intercepted precipitation. It may be less or greater than potential evapotranspiration.

Contour - An imaginary line connecting points of equal elevation on the surface of the soil.

Cover - This term generally has one of the following meanings:

1. Vegetation or other material providing protection
2. In forestry, low growing shrubs and herbaceous plants under trees (i.e., ground cover vs. tree cover)
3. Any vegetation producing a protective mat on or just above the soil surface.

Creep (soil) - Slow mass movement of soil and soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and by alternate freezing and thawing.

Decile portion - A one-tenth portion. As used in the soil map symbol A7-B3 means that the A soils cover seven tenths and the B soils cover three tenths of the map unit.

Delta - A fluvial or glaciofluvial fan shaped deposit at the mouth of a river that empties into a lake or sea.

Deflocculate - To separate or to break up soil aggregates into individual particles by chemical or physical means or both.

Degradation (of soils) - The changing of a soil to a more highly leached and more highly weathered condition, usually accompanied by morphological changes such as the development of an eluviated light colored (Ae) horizon.

Dispersion - Is rated high, moderate or low depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of high indicates that soil aggregates slake readily; a rating of low indicates that aggregates are resistant to dispersion and remain clumped together.

Drainage (soil) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil to underground spaces. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

Drainage in soil reports is described on the basis of actual moisture content in excess of field capacity and length of the saturation period within the plant root zone. The terms are as follows:

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Rapidly drained - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse in texture, or shallow, or both. Water source is precipitation.

Well drained - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are equaled by losses. These soils are usually free of mottles within 100 cm of the surface but may be mottled below this depth. Soil horizons are usually bright colored.

Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6cm) within the control section and are usually medium to fine in texture. Soils are commonly mottled in the 50 to 100 cm depth. Colors are dull brown in the subsoil with stains and mottles.

Imperfectly drained - Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is major supply. If subsurface water or groundwater, or both, is the main source, flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups. These soils generally have mottling below the surface layers and generally have duller colors with depth, generally brownish gray with mottles of yellow and gray.

Poorly drained - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Poorly drained soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. These soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

Dryland farming - The practice of crop production in low rainfall areas without irrigation.

Eluvial horizon - A horizon from which material has been removed in solution or in water suspension.

Eolian - Soil material accumulated through wind action.

Erosion - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes. The ratings of erosion are:

Erosion 1	slightly eroded - soil with a sufficient amount of the A horizon removed that ordinary tillage will bring up and mix the B horizon or other lower lying horizons with surface soil in the plow layer.
Erosion 2	moderately eroded - soil with all of the A horizon and a part of the B or other lower lying horizons removed. The plow layer consists mainly of the original horizons below the A or below the original plow layer.
Erosion 3	severely eroded - soils have practically all of the original surface soil removed. The plow layer consists mainly of C horizon material, especially on knolls and steep upper slope positions.

Evapotranspiration - The combined loss of water from a given area, and during a specific period of time, by evaporation from the soil surface and transpiration from plants.

Field Moisture Equivalent - The minimum moisture content at which a drop of water placed on a smoothed surface of the soil will not be absorbed immediately by the soil, but will spread out over the surface and give it a shiny appearance.

Flood plain - The land bordering a stream, built up of sediments from overflow of the stream and subject to innundation when the stream is at flood stage.

Fluvial deposits - All sediments past and present, deposited by flowing water, including glaciofluvial deposits.

Frost heave - The raising of the surface caused by ice in the subsoil.

Friable - Soil aggregates that are soft and easily crushed between thumb and forefinger.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. These deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers and kame terraces.

Gleyed soil - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well-drained soil.

Gleysolic - An order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas or prominent mottling or both, in some horizons.

Gravel - Rock fragments 2 mm to 7.5 cm in diameter.

Ground Moraine - An unsorted mixture of rocks, boulders, sand, silt and clay deposited by glacial ice. The predominant material is till; most till is thought to have accumulated under the ice by lodgment, but some till has been let down from the upper surface of the ice by ablation. Resorting and modification may have taken place to some extent by wave-action of glacial melt waters. The topography is most commonly in the form of undulating plains with gently sloping hills and enclosed depressions.

Groundwater - Water beneath the soil surface, usually under conditions where the voids are completely filled with water (saturation).

Halophytic vegetation - vegetation that grows naturally in soils having a high content of various salts. It usually has fleshy leaves or thorns and resembles desert vegetation.

Horizon (soil) - A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes.

Horizon boundary - The lower boundary of each horizon is described by indicating its distinctness and form. The distinctness depends on the abruptness of vertical change (thickness). The form refers to the variation of the boundary plane.

Distinctness -
abrupt - less than 2 cm
clear - 2 to 5 cm
gradual - 5 to 15 cm
diffuse - more than 15 cm

Form -
smooth - nearly plain
wavy - pockets are wider than deep
irregular - pockets are deeper than wide
broken - parts of the horizon are unconnected with other parts

Humic layer - A layer of highly decomposed organic soil material containing little fibre.

Hydraulic Conductivity - Refers to the effective flow velocity or discharge velocity in soil at unit hydraulic gradient. It is an approximation of the permeability of the soil and is expressed in cm per hour. The classes are described in general or specific terms as:

High	>15	Very rapid	>50
		Rapid	15-50
Medium	0.5-15	Mod. rapid	5.0-15
		Moderate	1.5-5.0
		Mod. slow	0.5-1.5
Low	<0.5	Slow	0.15-0.5
		Very slow	0.015-0.15
		Extremely slow	<.015

Hydrologic cycle - The conditions through which water naturally passes from the time of precipitation until it is returned to the atmosphere by evaporation and is again ready to be precipitated.

Hydrophyte - Plants growing in water or dependent upon wet or saturated soil conditions for growth.

Illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension. The layer of accumulation.

Impeded drainage - A condition that hinders the movement of water by gravity through the soils.

Inclusion - Soil type found within a mapping unit that is not extensive enough to be mapped separately or as part of a complex.

Infiltration - The downward entry of water into the soil

Irrigation - The artificial application of water to the soil for the benefit of growing crops.

Irrigation requirement (IR) - Refers to the amount of water exclusive of effective precipitation that is required for crop production.

Lacustrine deposits - Material deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of the land. These sediments range in texture from sand to clay and are usually varved (layered annual deposits).

Landforms - See Description of Landforms

Landscape - All the natural features such as fields, hills, forest, water, etc., which distinquish one part of the earth's surface from another part.

Leaching - The removal from the soil of materials in solution.

Liquid limit (upper plastic limit) - The water content corresponding to an arbitrary limit between the liquid and plastic states of consistency of a soil. The water content at this boundary is defined as that at which a pat of soil cut by a groove of standard dimensions will flow together for a distance of 1.25 cm under the impact of 25 blows in a standard liquid limit apparatus.

Lineal shrinkage - This is the decrease in one dimension expressed as a percentage of the original dimension of the soil mass when the moisture content is reduced from a stipulated percentage (usually field moisture equivalent) to the shrinkage limit.

Mapping Unit - Any delineated area shown on a soil map that is identified by a symbol. A mapping unit may be a soil unit, a miscellaneous land type, or a soil complex.

Marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

Mature soil - A soil having well-developed soil horizons produced by the natural processes of soil formation.

Mesophyte - Plants requiring intermediate moisture conditions and are not very resistant to drought.

Microrelief - Small-scale, local differences in relief including mounds, swales or hollows.

Milliequivalent (me) - One-thousandth of an equivalent. An equivalent is the weight in grams of an ion or compound that combines with or replaces one gram of hydrogen. The atomic or formula weight divided by valence.

Mottles - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue. They are described in order of abundance (few, common, many), size (fine, medium, coarse) and contrast (faint, distinct, prominent). Mottles in soils indicate poor aeration and lack of good drainage.

Organic carbon - Carbon derived from plant and animal residues.

Organic matter - The fraction of the soil which consists of plant and animal residues at various stages of decomposition, cells and tissues of soil organisms and substances synthesized by the soil population. It is determined on soils that have been sieved through a 2.0 mm sieve. It is estimated by multiplying the organic carbon by a factor of 1.72.

Outwash - Sediments "washed out" beyond the glacier by flowing water and laid down in thin beds or strata. Particle size may range from boulders to silt.

Ovendry soil - Soil that has been dried at 105 degrees C until it has reached constant weight.

Parent material - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

Particle size, soil - The grain size distribution of the whole soil including the coarse fraction. It differs from texture, which refers to the fine earth (less than 2mm) fraction only. In addition, textural classes are usually assigned to specific horizons whereas soil family particle-size classes indicate a composite particle size of a part of the control section that may include several horizons. See Textural Triangle at end of Glossary.

The particle-size classes for family groupings are as follows:

Fragmental Stones, cobbles and gravel, with too little fine earth to fill interstices larger than 1 mm.

Sandy-skeletal Particles coarser than 2 mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the sandy particle-size class.

Loamy-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the loamy particle-size class.

Clayey-skeletal Particles 2 mm-25 cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1 mm; the fraction finer than 2 mm is that defined for the clayey particle-size class.

Sandy The texture of the fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2 mm- 25 cm occupy less than 35% by volume.

Loamy The texture of the fine earth includes loamy very fine sand, very fine sand, and finer textures with less than 35% clay; particles 2 mm-25 cm occupy less than 35% by volume.

Coarse-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-loamy. A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Coarse-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction.

Fine-silty. A loamy particle size that has less than 15% of fine sand (0.25-0.1 mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction.

Clayey. The fine earth contains 35% or more clay by weight and particles 2mm-25 cm occupy less than 35% by volume.

Fine-clayey. A clayey particle size that has 35-60% clay in the fine earth fraction.

Very-fine-clayey. A clayey particle size that has 60% or more clay in the fine earth fraction.

Ped - An individual soil aggregate such as granule, prism or block formed by natural processes (in contrast with a clod which is formed artificially).

Pedology - Those aspects of soil science involving constitution, distribution, genesis and classification of soils.

Percolation - The downward movement of water through soil; specifically, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of 1.0 or less.

Permafrost -

1. Perennially frozen material underlying the solum.
2. A perennially frozen soil horizon.

Permafrost table - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

Permeability - The ease with which water and air pass through the soil to all parts of the profile. See hydraulic conductivity.

pH - The intensity of acidity and alkalinity, expressed as the negative logarithm of the hydrogen ion concentration. A pH of 7 is neutral, lower values indicate acidity and higher values alkalinity (see Reaction, soil).

Phase, soil - A soil phase is used to characterize soil and landscape properties that are not used as criteria in soil taxonomy. The major phase differentiae are: slope, erosion, deposition, stoniness, texture, salinity, and calcareousness.

Plastic Limit - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of a soil.

Plasticity Index - The numerical difference between the liquid and the plastic limit. The plasticity index gives the range of moisture contents within which a soil exhibits plastic properties.

Potential evapotranspiration (PE) - The maximum quantity of water capable of being lost as water vapor, in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water.

Profile, soil - A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil - The acidity or alkalinity of a soil. Soil reaction classes are characterized as follows:

extremely acid	pH <4.5
very strongly acid	4.5 to 5.0
strongly acid	5.1 to 5.5
medium acid	5.6 to 6.0
slightly acid	6.1 to 6.5
neutral	6.6 to 7.3
mildly alkaline	7.4 to 7.8
mod. alkaline	7.9 to 8.4
strongly alkaline	8.5 to 9.0
very strongly alkaline	>9.0

Regolith - The unconsolidated mantle of weathered rock and soil material on the earth's surface.

Relief - The elevation of inequalities of the land surface when considered collectively.

Runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

Saline Soil - A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 millisiemens/cm (ms/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5. Approximate limits of salinity classes are:

non-saline	0 to 4 ms/cm
weakly saline	4 to 8 mS/cm
mod. saline	8 to 15 ms/cm
strongly saline	>15 ms/cm

Salinization - The process of accumulation of salts in the soil.

Salt-Affected Soil - Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium or both.

Sand - A soil particle between 0.05 and 2.0 mm in diameter. The textural class name for any soil containing 85 percent or more of sand and not more than 10 percent of clay.

Saturation Percentage - The moisture percentage of a saturated soil paste, expressed on an oven dry weight basis.

Seepage -

1. The escape of water downward through the soil.
2. The emergence of water from the soil along an extensive line of surface in contrast to a spring where water emerges from a local spot.

Series, soil - A category in the Canadian System of Soil Classification. It consists of soils that have soil horizons similar in their differentiating characteristics and arrangement in the profile, except for surface texture and are formed from a particular type of parent material.

Shrinkage limit - This is the moisture content at which an equilibrium condition of volume change is reached and further reduction in moisture content will not cause a decrease in the volume of the soil mass.

Shrinkage ratio - This is the ratio between the volume change and a corresponding change in moisture content. It equals the apparent specific gravity of the dried soil.

Silt - (a) Individual mineral particles of soil that range in diameter between 0.05 to .002 mm. (b) Soil of the textural class silt contains greater than 80 percent silt and less than 12 percent clay.

Slickenside - Smoothed surfaces along planes of weakness resulting from the movement of one mass of soil against another in soils dominated by swelling clays.

Sodium-Adsorption Ratio (S.A.R.) - A ratio for soil extracts and irrigation waters used to express the relative activity of sodium ions in exchange reactions with other cations in the soil $SAR = Na/((Ca+Mg)/2)^{1/2}$ where the cation concentrations are expressed as milliequivalents per litre.

Soil - The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

Solum - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

Stones - Rock fragments greater than 25 cm in diameter.

Stoniness - The percentage of land surface occupied by stones. The classes of stoniness are defined as follows:

Stones 0. Nonstony -- Land having less than 0.01% of surface occupied by stones.

Stones 1. Slightly stony -- Land having 0.01-0.1% of surface occupied by stones. Stones 15-30 cm in diameter, 10-30 m apart. The stones offer only slight to no hindrance to cultivation.

Stones 2. Moderately stony -- Land having 0.1-3% of surface occupied by stones. Stones 15-30 cm in diameter, 2-10 m apart. Stones cause some interference with cultivation.

Stones 3. Very stony -- Land having 3-15% of surface occupied by stones. Stones 15-30 cm in diameter, 1-2 m apart. There are sufficient stones to constitute a serious handicap to cultivation.

Stones 4. Exceedingly stony -- Land having 15-50% of surface occupied by stones. Stones 15-30 cm in diameter, 0.7-1.5 m apart. There are sufficient stones to prevent cultivation until considerable clearing has been done.

Stones 5. Excessively stony -- Land having more than 50% of surface occupied by stones. Stones

15-30 cm in diameter, less than 0.7 m apart. The land is too stony to permit cultivation.

Storage Capacity - Refers to the maximum amount of readily available water that can be stored within the rooting zone of a crop in a given soil. For practical irrigation purposes, 50 percent of the total soil water between field capacity and wilting point may be considered as readily available.

Stratified materials - Unconsolidated sand, silt and clay arranged in strata or layers. In stratified materials, a bed is a unit layer distinctly separable from other layers and is one or more cm thick but a lamina is a similar layer less than 1 cm thick.

Structure - The combination or arrangement of primary soil particles into aggregates of secondary soil particles, units or peds, which are separated from each other by surfaces of weakness. Structure is expressed in terms of grade, size class and shape type. Grade refers to the distinctness of aggregate development, and is described as structureless, weak, moderate or strong. Structureless refers to the absence of observable aggregation of definite orderly arrangement; the term amorphous is used if soil is massive or coherent, single-grained if noncoherent. The weak to strong aggregates vary in size and are described by class as fine, medium, coarse, and very coarse depending on the shape types. The shape types refers to the dominant configuration of the aggregates and the way they are accommodated. The general shape types are plate-like, block-like and prism-like. The terms are:

Platy - Having thin, plate-like aggregates with faces mostly horizontal

Prismatic - Having prism-like aggregates with tops and edges, appear plane, level and somewhat angular.

Columnar - Having prism-like aggregates with vertical edges near the top of columns, not sharp.

Granular - Having block-like aggregates that appear as spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of the surrounding peds.

Blocky - Having block-like aggregates with sharp, angular corners

Subangular blocky - Having block-like aggregates with rounded and flattened faces and rounded corners.

By convention an aggregate is described in the order of grade, class and type, e.g. strong, medium, blocky. In the parent material of soils the material with structural shapes may be designated as pseudo-blocky, pseudo-platy, etc.

Soil Survey - The systematic examination, description, classification, and mapping of soil in an area.

Sulfate Hazard - Refers to the relative degree of attack on concrete by soil and water containing various amounts of sulfate ions. It is estimated from electrolyte measurements and salt analysis on selected profiles and soil samples, and by visual examination of free gypsum within the profile during the course of soil investigation.

Swamp - See Description of Landforms

Texture, soil - The relative proportions of the fine earth (less than 2 mm.) fraction of a soil. Textural classes are usually assigned to specific horizons whereas family particle size classes indicate a composite particle size of a portion of the control section that may include several horizons. See Texture Triangle at end of Glossary.

The size range of the constituent primary particles are as follows:

	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	< 0.002
Fine clay	< 0.0002

Till, glacial - Unstratified glacial deposits consisting of clay, sand, gravel, and boulders intermingled in any proportion.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergency and root penetration.

Topography - Refers to the percent slope and the pattern or frequency of slopes in different directions. A set of 10 slope classes are used to denote the dominant but not necessarily most abundant slopes within a mapping unit.

Slope Class	Slope Name	Percent slope	Approx. degrees
1	level	0-0.5	0
2	nearly level	.5-2.5	.3-1.5
3	very gentle	2-5	1-3
4	gentle	6-9	3.5-5
5	moderate	10-15	6-8.5
6	strong	16-30	9-17
7	very strong	31-45	17-24
8	extreme	46-70	25-35
9	steep	71-100	35-45
10	very steep	>100	>45

Underground runoff - (or seepage)-Water flowing towards stream channels after infiltration into the ground.

Unified Soil Classification System (engineering) - A classification system based on the identification of soils according to their particle size, gradation, plasticity index and liquid limit.

Urban Land - Areas so altered or obstructed by urban works or structures that identification of soils is not feasible.

Variant, soil - A soil whose properties are believed to be sufficiently different from other known soils to justify a new series name, but comprising such a limited geographic area that creation of a new series is not justified.

Varve - A distinct band representing the annual deposit in sedimentary materials regardless of origin and usually consisting of two layers, one thick light colored layer of silt and fine sand laid down in the spring and summer, and the other a thin, dark colored layer of clay laid down in the fall and winter.

Water balance, soil - Is the daily amount of readily available water retained by the soil. The daily soil-water balance is decreased by the amount that the daily consumptive use exceeds the daily rainfall. When daily rainfall exceeds the consumptive use, the daily balance increases by the amount of the difference unless the soil-water balance is at storage capacity, in which case the excess is assumed to be lost by runoff or deep percolation.

Water table - (groundwater surface; free water surface; groundwater elevation) Elevation at which the pressure in the water is zero with respect to the atmospheric pressure.

Water-holding capacity - The ability of a soil to hold water against the force of gravity in a freely drained soil.

Weathering - The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.

Xerophyte - Plants capable of surviving extended periods of soil drought.

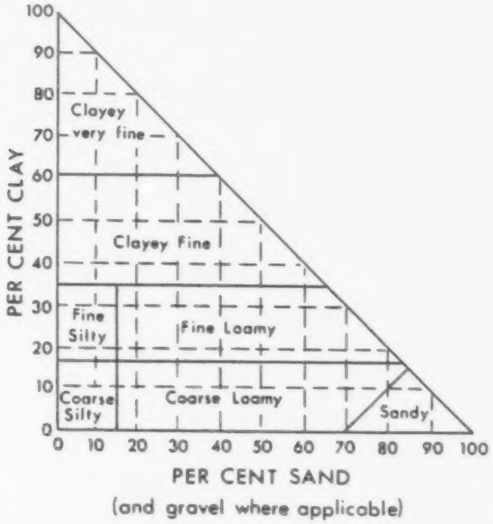
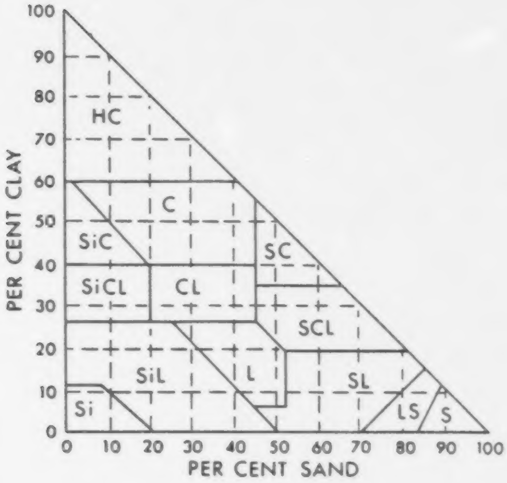

100
90
80
70
60
50
40
30
20
10
0
Clayey very fine
Clayey Fine
Fine Silty
Fine Loamy
Coarse Silty
Coarse Loamy
Sandy
PER CENT CLAY
0 10 20 30 40 50 60 70 80 90 100
PER CENT SAND
(and gravel where applicable)

Figure 7: Family particle-size classes.


100
90
80
70
60
50
40
30
20
10
0
HC
C
SiC
SC
SiCL
CL
SCL
SiL
L
SL
Si
LS
S
PER CENT CLAY
0 10 20 30 40 50 60 70 80 90 100
PER CENT SAND

Texture Group	Class Symbol	Class Name
Coarse	S	sand
	LS	loamy sand
Moderately coarse	SL	sandy loam
	LVFS	loamy very fine sand
Medium	Si	silt
	SiL	silt loam
	L	loam
	VFSL	very fine sandy loam
Moderately fine	SCL	sandy clay loam
	CL	clay loam
	SiCL	silty clay loam
Fine	SC	sandy clay
	C	clay
	SiC	silty clay
Very fine	HC	heavy clay

Figure 8: Soil Textural Classes.

Appendix B

SOIL HORIZON DESIGNATIONS

ORGANIC HORIZONS

Organic horizons are found in Organic soils, and commonly at the surface of mineral soils. They may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups of these horizons are recognized, O horizons and the L, F, and H horizons.

O This is an organic horizon developed mainly from mosses, rushes, and woody materials.

Of The fibric horizon is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fiber that are readily identifiable as to botanical origin. A fibric horizon has 40% or more of rubbed fiber by volume and a pyrophosphate index of 5 or more. If the rubbed fiber volume is 75% or more, the pyrophosphate criterion does not apply.

Om The mesic horizon is the intermediate stage of decomposition with intermediate amounts of fiber, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic horizon is one that fails to meet the requirements of fibric or humic.

Oh The humic horizon is the most highly decomposed of the organic soil materials. It has the least amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained. The humic horizon has less than 10% rubbed fiber by volume and a pyrophosphate index of 3 or less.

LFH These organic horizons developed primarily from leaves, twigs, woody materials and a minor component of mosses under imperfectly to well drained forest conditions.

L This is an organic horizon characterized by an accumulation of organic matter in which the original structures are easily discernible.

F This is an organic horizon characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The horizon may be partly comminuted by soil fauna as in moder, or it may be a partly decomposed mat permeated by fungal hyphae as in mor.

H This is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification chiefly through the action of organisms. It is frequently intermixed with mineral grains, especially near the junction with the mineral horizon.

MASTER MINERAL HORIZONS

Mineral horizons are those that contain less than 30% organic matter by weight as specified for organic horizons.

A This is a mineral horizon or horizons formed at or near the surface in the zone of leaching or removal of materials in solution and suspension or of maximum in situ accumulation of organic matter, or both. Included are:

1. horizons in which organic matter has accumulated as a result of biological activity (Ah);
2. horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of them (Ae);
3. horizons having characteristics of 1) and 2) above but transitional to underlying B or C (AB or A and B);
4. horizons markedly disturbed by cultivation or pasture (Ap).

B This is a mineral horizon or horizons characterized by one or more of the following:

1. an enrichment in silicate clay, iron, aluminum, or humus, alone or in combination (Bt,Bf,Bfh,Bhf, and Bh);
2. a prismatic or columnar structure that exhibits pronounced coatings or stainings and significant amount of exchangeable Na (Bn);
3. an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both, and does not meet the requirements of 1) and 2) above (Bm,Bg).

C This is a mineral horizon or horizons comparatively unaffected by the pedogenic processes operative in A and B, excepting (i) the process of gleying, and (ii) the accumulation of calcium and magnesium carbonates and more soluble salts (Cca,Csa,Cg, and C). Marl and diatomaceous earth are considered to be C horizons.

R This is consolidated bedrock that is too hard to break with the hands or to dig with a spade when moist and that does not meet the requirement of a C horizon. The boundary between the R layer and overlying unconsolidated material is called a lithic contact.

W This is a layer of water in Gleysolic, Organic, or Cryosolic soils. It is called a hydric layer in Organic soils.

LOWER-CASE SUFFIXES

b Buried soil horizon.

c A cemented (irreversible) pedogenic horizon. The ortstein of a Podzol, and a layer cemented by calcium carbonate and a duripan are examples.

ca	A horizon with secondary carbonate enrichment where the concentration of lime exceeds that present in the unenriched parent material. It is more than 10 cm thick, and if it has a CaCO3 equivalent of less than 15 percent it should have at least 5 percent more CaCO3 equivalent than the parent material (IC). If it has more than 15 percent CaCO3 equivalent it should have 1/3 more CaCO3 equivalent than the IC. If no IC is present, this horizon is more than 10 cm thick and contains more than 5 percent by volume of secondary carbonates in concretions or soft, powdery forms.
cc	Cemented (irreversible) pedogenic concretions.
e	A horizon characterized by the eluviation of clay, iron, aluminum, or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).
f	A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less. It contains 0.6% or more pyrophosphate-extractable Al+Fe in textures finer than sand and 0.4% or more in sands (coarse sand, sand, fine sand, and very fine sand). The ratio of pyrophosphate-extractable Al+Fe to clay (less than 0.002mm) is more than 0.05 and organic C exceeds 0.5%. Pyrophosphate-extractable Fe is at least 0.3%, or the ratio of organic C to pyrophosphate-extractable Fe is less than 20, or both are true. It is used with B alone (Bf), with B and h (Bhf), with B and g (Bfg), and with other suffixes. The criteria for "f" do not apply to Bgf horizons. The following horizons are differentiated on the basis of organic carbon content: Bf - 0.5% to 5% organic carbon. Bhf-more than 5% organic carbon.
g	A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less. It is used with A and e (Aeg); with B alone (Bg); with B and f (Bfg); with B, h, and f (Bhfg); with B and t (Btg); with C alone (Cg); with C and k (Ckg); and several others. In some reddish parent materials, matrix colors of reddish hues and high chromas may persist despite long periods of reduction. In these soils, horizons are designated as g if there is gray mottling or if there is marked bleaching on ped faces or along cracks.
Aeg	This horizon must meet the definitions of A,e, and g.
Bg	These horizons are analogous to Bm horizons but they have colors indicative of poor drainage and periodic reduction. They include horizons occurring between A and C horizons in which the main features are (i) colors of low chroma, that is: chromas of 1 or less, without mottles on ped surfaces or in the matrix if peds are lacking; or chromas of 2 or less in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by more

prominent mottles than those in the C horizon; or hues bluer than 10Y, with or without mottles on ped surfaces or in the matrix if peds are lacking. (ii) colors indicated in (i) and a change in structure from that of the C horizons. (iii) color indicated in (i) and illuviation of clay too slight to meet the requirements of Bt; or accumulation or iron oxide too slight to meet the limits of Bgf. (iv) colors indicated in (i) and removal of carbonates. Bg horizons occur in some Orthic Humic Gleysols and some Orthic Gleysols.

Bfg, Bhfg, Btg, and others. When used in any of these combinations the limits set for f, hf, t, and others must be met.

Bgf The dithionite-extractable Fe of this horizon exceeds that of the IC by 1% or more. Pyrophosphate-extractable Al + Fe is less than the minimum limit specified for 'f' horizons. This horizon occurs in Fera Gleysols and Fera Humic Gleysols, and possibly below the Bfg of gleyed Podzols. It is distinguished from the Bfg of gleyed Podzols on the basis of the extractability of the Fe and Al. The Fe in the Bgf horizon is thought to have accumulated as a result of the oxidation of ferrous iron. The iron oxide formed is not associated intimately with organic matter or with Al, and it is sometimes crystalline. The Bgf horizons are usually prominently mottled, with more than half of the soil material occurring as mottles of high chroma.

Cg, Ckg, Ccag, Csg, Csag. When g is used with C alone, or with C and one of the lower-case suffixes k, ca, s, or sa, it must meet the definiton for C and for the particular suffix.

h A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

Ah A horizon enriched with organic matter that either has a color value at least one unit lower than the underlying horizon or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

Ahe An Ah horizon that has undergone eluviation as evidenced, under natural conditions, by streaks and splotches of differing shades of gray and often by platy structure. It may be overlain by a darker-colored Ah and underlain by a lighter-colored Ae.

Bh This horizon contains more than 1% organic carbon, less than 0.3% pyrophosphate-extractable Fe, and has a ratio of organic carbon to pyrophosphate-extractable Fe of 20 or more. Generally the color value and chroma are less than 3 when moist.

Bhf Defined under 'f'.

j Used as a modifier of the suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies. For example Bfgj means a Bf horizon with weak expression of gleying; Bfjgj means a B horizon with weak expression of both 'f' and 'g' features.

Aej It denotes an eluvial horizon that is thin, discontinuous or slightly discernible.

Btj It is a horizon with some illuviation of clay, but not enough to meet the limits of Bt.

Btgj, Bmgj. Horizons that are mottled but do not meet the criteria of Bg.

Bfj It is a horizon with some accumulation of pyrophosphate-extractable Al and Fe but not enough to meet the limits of Bf.

Bntj or Bnj. Horizons in which development of solonetzic B properties is evident but insufficient to meet the limits for Bn or Bnt.

k Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah or Ap (Ahk, Apk), or organic horizons (Ofk, Omk).

m A horizon slightly altered by hydrolysis, oxidation, or solution, or all three, to give a change in color or structure, or both. It has:

1. Evidence of alteration in one of the following forms:

   a) Higher chromas and redder hues than the underlying horizons.

   b) Removal of carbonates, either partially (Bmk) or completely (Bm).

2. Illuviation, if evident, too slight to meet the requirements of a Bt or a podzolic B.

3. Some weatherable minerals.

4. No cementation or induration and lacks a brittle consistence when moist. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

n A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistence when dry. It is used with B, as Bn or Bnt.

p A horizon disturbed by man's activities, such as cultivation, logging, habitation, etc. It is used with A and O.

s A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants. It is commonly used with C and k (Csk), but can be used with any horizon or combination of horizon and lowercase suffix.

sa A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material. The horizon is 10 cm or more thick. The conductivity of the saturation extract must be at least 4 ms/cm and must exceed that of the C horizon by at least one-third.

t An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc.

Bt A Bt horizon is one that contains illuvial layer-lattice clays. It forms below an eluvial horizon, but may occur at the surface of a soil that has been partially truncated. It usually has a higher ratio of fine clay to total clay than IC. It has the following properties:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizons, as follows:
    - a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (2mm) the Bt horizon must contain at least 3% more clay, e.g.,Ae 10% clay-Bt minimum 13% clay.
    - b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more, e.g., 20% clay increase in the Bt over Ae.
    - c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon, e.g. Ae 50% clay; Bt at least 58% clay.
2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.
3. In massive soils the Bt horizon should have oriented clays in some pores and also as bridges between the sand grains.
4. If peds are present, a Bt horizon shows clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or shows oriented clays in 1% or more of the cross section, as viewed in thin section.
5. If a soil shows a lithologic discontinuity between the eluvial

horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part, either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that some part of the horizon has about 1% or more of oriented clay bodies.

Btj, Btj, and Btg are defined under j and g.

u A horizon that is markedly disrupted by physical or faunal processes other than cryoturbation. Evidence of marked disruption such as the inclusion of material from other horizons, absence of the horizon, etc. must be evident in at least half of the cross section of the pedon. Such turbation can result from blowdown of trees, mass movement of soil on slopes, and burrowing animals. It can be used with any horizon or subhorizon with the exception of A or B alone; e.g. Aeu, Bfu, BCu.

x A horizon of fragipan character. A fragipan is a loamy subsurface horizon of high bulk density and very low organic matter content. When dry, it has a hard consistence and seems to be cemented. When moist, it has moderate to weak brittleness. It frequently has bleached fracture planes and is overlain by a friable B horizon. Air dry clods of fragic horizons slake in water.

y A horizon affected by cryoturbation as manifested by disrupted and broken horizons,, incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon. It is used with A, B, and C alone or in combination with other subscripts, e.g. Ahy, Ahgy, Bmy, Cy, Cgy, Cygj, etc.

z A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

Appendix C

DESCRIPTION OF LANDFORMS

C.1 GENETIC MATERIALS

Unconsolidated mineral component

The unconsolidated mineral component consists of clastic sediments that may or may not be stratified, but whose particles are not cemented together. They are essentially of glacial or post-glacial origin but include poorly consolidated and weathered bedrock.

Anthropogenic - Man-made or man-modified materials, including those associated with mineral exploitation and waste disposal.

Colluvial - Massive to moderately well stratified, nonsorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movement.

They are restricted to products of mass-wasting whereby the debris is not carried by wind, water, or ice (excepting snow avalanches).

Eolian - Sediment, generally consisting of medium to fine sand and coarse silt particle sizes, that is well sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting.

These materials have been transported and deposited by wind action.

Fluvial - Sediment generally consisting of gravel and sand with a minor fraction of silt and clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well sorted and display stratification, but massive, nonsorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. Finer textured Fluvial deposits of modern rivers are termed Alluvium.

Lacustrine - Sediment generally consisting of either stratified fine sand, silt, and clay deposited on the lake bed; or moderately well sorted and stratified sand and coarser materials that are beach and other nearshore sediments transported and deposited by wave action.

These are materials that either have settled from suspension in bodies of standing fresh water or have accumulated at their margins through wave action.

Marine - Unconsolidated deposits of clay, silt, sand, or gravel that are well to moderately well sorted and well stratified to moderately stratified (in some places containing shells). They have settled from suspension in salt or brackish water bodies or have accumulated at their margins through shoreline processes such as wave action and longshore drift.

Morainal - Sediment generally consisting of well compacted material that is nonstratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt, and clay that has been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent.

Saprolite - Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering.

The rock remains in a coherent state, interstitial grain relationships are undisturbed and no downhill movement due to gravity has occurred.

Undifferentiated - A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment.

Volcanic - Unconsolidated pyroclastic sediments. These include volcanic dust, ash, cinders, and pumice.

Qualifying Descriptors

These have been introduced to qualify the genetic materials and to supply additional information about the mode of formation or depositional environment.

Glacial - Used to qualify nonglacial genetic materials or process modifiers where there is direct evidence that glacier ice exerted a strong but secondary or indirect control upon the mode of origin of the materials or mode of operation of the process. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material or the site of operation of a process.

Glaciofluvial - Fluvial materials showing clear evidence of having been deposited either directly in front of or in contact with glacier ice.

Glaciolacustrine - Lacustrine materials deposited in contact with glacial ice.

Glaciomarine - Materials of glacial origin laid down in a marine environment, as a result of settling from melting, floating ice and ice shelves.

Organic component

The organic component consists of peat deposits containing >30% organic matter by weight that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick. The classes and their definitions follow.

B	Bog
N	Fen
S	Swamp

Bog - A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

__Fen__ - A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

__Swamp__ - A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

C.2 GENETIC MATERIAL MODIFIERS

Material modifiers are used to qualify unconsolidated mineral and organic deposits. Particle-size classes serve to indicate the size, roundness, and sorting of unconsolidated mineral deposits. Fiber classes indicate the degree of decomposition and fiber size of organic materials.

Particle size classes for unconsolidated mineral materials

Blocky: An accumulation of angular particles greater than 256 mm in size.

Bouldery: An accumulation of rounded particles greater than 256 mm in size.

Clayey: An accumulation of particles where the fine earth fraction contains 35% or more clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Cobbly: An accumulation of rounded particles having a diameter of 64-256 mm.

Gravelly: An accumulation of rounded particles ranging in size from pebbles to boulders.

Loamy: An accumulation of particles of which fine earth fraction contains 35% or less clay (<0.002 mm) by weight and particles greater than 2 mm are less than 35% by volume.

Pebbly: An accumulation of rounded particles having a diameter of 2-64 mm.

Rubbly: An accumulation of angular fragments having a diameter of 2-256 mm.

Sandy: An accumulation of particles of which the fine earth fraction contains more than 70% by weight of fine sand or coarser particles. Particles greater than 2 mm occupy less than 35% by volume.

Silty: An accumulation of particles of which the fine earth fraction contains less than 15% of fine sand or coarser particles and has less than 35% clay. Particles greater than 2 mm occupy less than 35% by volume.

Fiber classes for organic materials

The amount of fiber and its durability are important characterizing features of organic deposits in that they reflect on the degree of decomposition of the material. The prevalence of woody materials in peats is also of prime importance.

Fibric: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

Mesic: Organic material in an intermediate stage of decompostion; intermediate amounts of fiber are present that can be identified as to their botanical origin.

Humic: Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.

Woody: Organic material containing more than 50% of woody fibers.

C.3 SURFACE EXPRESSION

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials. When applied to consolidated materials, form refers to the product of their modification by geological processes. Surface expression also indicates the manner in which unconsolidated genetic materials relate to the underlying unit.

Consolidated and Unconsolidated mineral surface classes

Apron - A relatively gentle slope at the foot of a steeper slope and formed by materials from the steeper, upper slope.

Blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but still conforming to the general underlying topography.

Fan - A fan-shaped form similar to the segment of a cone and having a perceptible gradient from the apex to the toe.

Hummocky - A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally 9-70% (5-35 degrees).

Inclined - A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are 2-70% (1-35 degrees). The form of inclined slopes is not related to the initial mode of origin of the underlying material.

Level - A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 2% (1 degree).

Rolling - A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wavelake pattern of moderate relief. Slope length is often 1.6 km or greater and gradients are greater than 5% (3 degrees).

Ridged - A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, subparallel, or intersecting.

Steep - Erosional slopes, greater than 70% (35 degrees), on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material.

Terraced - Scarp face and the horizontal or gently inclined surface (tread) above it.

Undulating - A very regular sequence of gentle slopes that extends from rounded, sometimes confined concavities to broad rounded convexities producing a wavelike pattern of low local relief. Slope length is generally less than 0.8 km and the dominant gradient of slopes is 2-5% (1-3 degrees).

Veneer - Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range from 10 cm to 1 m in thickness and will possess no form typical of the material's genesis.

Organic surface classes

Blanket - A mantle of organic materials that is thick enough to mask minor irregularities in the underlying unit but still conforms to the general underlying topography.

Bowl - A bog or fen occupying concave-shaped depressions.

Domed - A bog with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or have a stepped surface.

Floating - A level organic surface associated with a pond or lake and not anchored to the lake bottom.

Horizontal - A flat peat surface not broken by marked elevations and depressions.

Plateau - A bog with an elevated, flat, central area only slightly higher than the margin.

Ribbed - A pattern of parallel or reticulate low ridges associated with fens.

Sloping - A peat surface with a generally constant slope not broken by marked irregularities.

Veneer - A thin (40 cm-1m) mantle of organic materials which generally conforms to the underlying topography. They may or may not be associated with discontinuous permafrost.

Appendix D

GUIDES FOR EVALUATING SOIL SUITABILITY FOR SELECTED USES

TABLE 11

Land Classification Standards for Irrigation Suitability

Land Characteristics	Subclass	Class 1 - Very Good	Class 2 - Good	Class 3 - Fair	Class 4 - Poor
SOILS	S				
Texture					
very coarse textured very fine textured	v h	Fine sandy loams to clay loams	Loamy fine sand to light clay	Sand to permeable clay	Gravel to clay
Water holding capacity low available moisture capacity	q	40 to 60 sat. % >15cm storage in 1.2m <10cm/hr. hydraulic cond.	35 to 65 sat. % >12.5cm storage in 1.2m <12.5cm/hr. hydraulic cond.	25 to 75 sat. % >7.5cm storage in 1.2m <17.5cm/hr. hydraulic cond.	<25 or >75 sat. % <7.5cm storage in 1.2m >17.5cm/hr. hydraulic cond.
Geological Deposit shallow deposit over sand or gravel	k	.9m or more of fine sandy loam or heavier	.6m or more of fine sandy loam or heavier, or .75m plus of loamy fine sand or sandy loam	.5m or more of sandy loam or heavier, or .6m plus of loamy sand	<.5m of sandy loam or heavier, or .6m of loamy sand or sand
shallow deposit over impervious substrata	b	>3m of permeable material	>2m of permeable material	>1m of permeable material	<1m of permeable material
Salinity and Alkalinity[1,2]	a	<4 ms/cm in 0-.6m <8 ms/cm below .6m <6 S.A.R.	<4 ms/cm in 0-.6m <12 ms/cm below .6m <8 S.A.R.	<8 ms/cm in 0-.6m <15 ms/cm below .6m <12 S.A.R.	>8 ms/cm in 0-.6m >15 ms/cm below .6m >12 S.A.R.
EXTERNAL FEATURES					
Stones - rock clearing	r	None to light clearing	Light to medium clearing	Light to heavy clearing	Excessively stony
Topography Slope excess gradient	T g	<1% and 0.1% in general gradient (0-3% slope)	<3% in general gradient (3-5% slope)	<5% in general gradient (5-10% slope)	>5% in general* gradient (>10% slope)**
DRAINAGE	D				
restricted outlet		No problem anticipated	Moderate drainage problem anticipated but may be improved at relatively low cost	Moderate to severe drainage problem anticipated but may be improved by expensive but feasible measures	Drainage improvement not considered feasible
water table		below 2.4m most of year	could be above 1.5m for a short period, then recedes to 2.4m or lower	within 1.5m most of year	within 1m most of year

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* Criteria for gravity (flood) irrigation requirements.

** Estimated adjustments to slope criteria for overhead or sprinkler type irrigation methods.

[1] If sufficient gypsum is present in the soil, the S.A.R. may be lowered by leaching the soil (a very slow process), and the hydraulic conductivity may then improve.

[2] The degree of salinity may vary widely within short distances, and there may be no clear indication of the area occupied by each salinity class. Unless a very detailed mapping and sampling program is carried out, it is impossible to estimate the acreage occupied by each salinity class.

TABLE 12

Guide for Assessing Soil Suitability as Source of Topsoil

The term "topsoil" includes soil materials used to cover barren surfaces exposed during construction, and materials used to improve soil conditions on lawns, gardens, flower beds, etc. The factors to be considered include not only the characteristics of the soil itself, but also the ease or difficulty of excavation, and where removal of topsoil is involved, accessibility to the site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
u	Moist Consistence[2]	Very friable, friable	Loose, firm	Very firm	Cemented
i	Flooding	None	May flood occasionally for short periods	Frequent flooding	Constantly flooded
w	Wetness[2]	Wetness is not determining if better than very poorly drained.			Very poorly drained and permanently wet soils
t	Slope	0-5%	5-9%	9-15%	>15%
p	Stoniness[2]	Stones 10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones 0.1 m apart (Class 5)
c	Coarse fragments[2]: percent, by volume	<3%	3-15%	15-35%	>35%
s	Texture[2]	FSL, VFSL, L, SiL, SL, SC if 1:1 clay is dominant	CL, SCL, SiCL, SC if 2:1 clay is dominant; c and sic if 1:1 clay is dominant	S, LS, C and SiC if 2:1 clay is dominant. organic soils[3]	Marl, diatomaceous earth
b	Depth of Topsoil[4]	>40 cm	15-40 cm	8-15 cm	<8 cm
n	Salinity of Topsoil[5]	E.C. 0-1	E.C. 1-4	E.C. 4-8	E.C. >8

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[1] The symbols are used to indicate the nature of the limitation.

[2] For an explanation of texture, consistence, stoniness, coarse fragments and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[3] Non-woody organic materials are assessed as good sources for topsoil if mixed with or incorporated into mineral soil.

[4] The remaining soil material (at least 8 cm) must be reclaimable after the uppermost soil is removed.

[5] E.C. = Electrical Conductivity (millisiemens/cm).

TABLE 13

Guide for Assessing Soil Suitability as Source of Sand and Gravel

The purpose of this table is to provide guidance for assessing the probable supply as well as quality of the sand or gravel for use as road base material and in concrete. The interpretation pertains mainly to the characteristics of the soil substratum to a depth of 150 cm, augmented by observations made in deep cuts as well as geological knowledge where available.

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
a	Unified Soil Group	SW SP GW GP	SW-SM SP-SM GP-GM GW-GM	SM SW-SC SP-SC GM GP-GC GW-GC	All other groups and bedrock
h	Depth to Seasonal Water Table	Not class determining if deeper than 50 cm		50 cm	
q	Depth to Sand and Gravel	<25 cm	25-75 cm[2/]	>75 cm[2/]	
p	Stoniness[3/]	Not class determining if stones >.5 m apart (Class 0, 1, 2 and 3)		Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
d	Depth to Bedrock	>100 cm	50-100 cm	<50 cm	

[1/] The symbols are used to indicate the nature of the limitation.

[2/] Rated good if it is known that the underlying gravel or sand deposit is thick (>100 cm).

[3/] For an explanation of stoniness and rockiness, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 14

Guide for Assessing Soil Suitability as Source of Roadfill

Fill material for buildings or roads are included in this use. The performance of the material when removed from its original location and placed under load at the building site or road bed are to be considered. Since surface materials are generally removed during road or building construction their properties are disregarded. Aside from this layer, the whole soil to a depth of 150-200 cm should be evaluated. Soil materials which are suitable for fill can be considered equally suited for road subgrade construction.

Symbol[1]	Items Affecting Use[2]	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Subgrade[3]				
	a. AASHO group index[4]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[5] and SC[5]	CL (with P.I.[6] <15) and ML	CL (with P.I.[6] of 15 or more), CH and MH[7]	OL, OH and Pt
l	Shrink-swell potential	Low	Moderate	High	
f	Susceptibility to frost action[8]	Low	Moderate	High	
t	Slope	0-15%	15-30%	30-45%	>45%
p	Stoniness[9]	Stones >2 m apart (Class 0, 1 and 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[9]	Rock exposures >35 m apart and cover <10% of the surface	Rock exposure 10-35 m apart and cover 10-25% of the surface	Rock exposure 3.5-10 m apart and cover 25-50% of the surface	Rock exposures < 3.5 m apart and cover 50-90% of the surface
w	Wetness[9]	Excessively drained to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
d	Depth to Bedrock	>100 cm	50-100 cm	20-50 cm	<20 cm
h	Depth to Seasonal Water Table	>150 cm	75-150 cm	50-75 cm	<50 cm

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[1] The symbols are used to indicate the nature of the limitation.

[2] The first three items pertain to soil after it is placed in a fill; the last six items pertain to soil in its natural condition before excavation for road fill.

[3] This item estimates the strength of the soil material, that is, its ability to withstand applied loads.

[4] Use AASHO group index only where laboratory data are available for the kind of soil being rated; otherwise, use Unified soil groups.

[5] Downgrade suitability rating to fair if content of fines is more than about 30 percent.

[6] P.I. means plasticity index.

[7] Upgrade suitability rating to fair if MH is largely kaolinitic, friable, and free of mica.

[8] Use this item only where frost penetrates below the paved or hardened surface layer and where moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front.

[9] For an explanation of stoniness, rockiness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

TABLE 15

Guide for Assessing Soil Suitability for Permanent Buildings

This guide applies to undisturbed soils to be evaluated for single-family dwellings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundation requirements; but soil slope, susceptibility to flooding and other hydrologic conditions, such as wetness, that have effects beyond those related exclusively to foundations are considered too. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability[3]			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[4]	With Basements: Very rapidly, rapidly and well drained. Without Basements: Very rapidly, rapidly, well and moderately well drained.	With Basements: Moderately well drained. Without Basements: Imperfectly drained.	With Basements: Imperfectly, poorly, and very poorly drained. Without Basements: Poorly and very poorly drained.	With Basements: Permanently wet soils. Without Basements: Permanently wet soils.
h	Depth to Seasonal Water Table	With Basements: >150 cm Without Basements: >75 cm	With Basements: 75-150 cm Without Basements: 50-75 cm	With Basements: 25-75 cm Without Basements: 25-50 cm	With Basements: <25 cm Without Basements: <25 cm
i	Flooding	None	None	Occasional flooding (once in 5 years)	Frequent flooding (every year)
t	Slope[5]	0-9%	9-15%	15-30%	>30%
s	Subgrade[6]				
	a. AASHO group index[7]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM and GC and SC	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Potential Frost Action[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[4]	Stones >10 m apart (Class 0 to 1)	Stones 2-10 m apart (Class 2[10])	Stones 0.1-2 m apart (Class 3[10] to 4)	Stones <0.1 m apart (Class 5[10])
r	Rockiness[4],[11]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to allow location of permanent buildings
d	Depth to Bedrock[11]	With Basements: >150 cm Without Basements: >100 cm	With Basements: 100-150 cm Without Basements: 50-100 cm	With Basements: 50-100 cm Without Basements: <50 cm	With Basements: <50 cm

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[1] By halving the slope limits, this table can be used for evaluating soil suitability for buildings with large floor areas, but with foundation requirements not exceeding those of ordinary three-storey dwellings.

[2] The symbols are used to indicate the nature of the limitation.

[3] Some soils assessed as fair or poor may be good sites from an aesthetic or use standpoint, but they will require more site preparation and/or maintenance.

[4] For an explanation of rockiness, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Reduce the slope limits by one half for those soils subject to hillside slippage.

[6] This item estimates the strength of the soil, that is, its ability to withstand applied loads. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used.

[7] Group index values were estimated from information published by the Portland Cement Association (PCA, 1962), pp. 23-25.

[8] P.I. means plasticity index.

[9] Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp. 5-8.

[10] Rate one class better for buildings without basements.

[11] Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment such as backhoes.

TABLE 16

Guide for Assessing Soil Suitability for Local Roads and Streets

This guide applies to soils to be evaluated for construction and maintenance of local roads and streets. These are improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete, and are expected to carry automobile traffic all year. They consist of: (1) the underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock, or lime or soil cement stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water and have ordinary provisions for drainage. With the probable exception of the hardened surface layer, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 2 meters. Excluded from consideration in this guide are highways designed for fast-moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill. The AASHO and Unified Classification give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth of hardrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill to reach an even grade.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[3]	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained	Permanently wet soils
i	Flooding	None	Infrequent (once in 5 years)	Occasional (once in 2-4 years)	Frequent (every year)
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Bedrock[4]	>100 cm	50-100 cm	<50 cm	
a	Subgrade[5]				
	a. AASHO group index[6]	0-4	5-8	>8	
	b. Unified soil classes	GW, GP, SW, SP, SM, GC[7] and SC[7]	CL (with P.I.[8] <15) and ML	CL (with P.I.[8] of 15 or more), CH and MH	OH, OL and Pt
f	Susceptibility to Frost Heave[9]	Low (F1, F2)	Moderate (F3)	High (F4)	
p	Stoniness[3]	Stones >2 m apart (Class 0 to 2)	Stones 0.5-2 m apart (Class 3)	Stones 0.1-0.5 m apart (Class 4)	Stones <0.1 m apart (Class 5)
r	Rockiness[3]	Rock exposures >100 m apart and cover <2% of the surface	Rock exposures 30-100 m apart and cover 2-10% of the surface	Rock exposures <30 m apart and cover >10% of the surface	Rock exposures too frequent to permit location of roads and streets

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[1] These guidelines, with some adjustment of slope and rockiness limits, will also be useful for assessing soils for use as parking lots.

[2] Symbols are used to indicate the nature of the limitation.

[3] For an explanation of stoniness, rockiness and soil drainage classes, see the Canada Soil Information System (Canada Soil Survey Committee, 1978).

[4] Rate one class better if the bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery.

[5] This item estimates the strength of soil materials as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise, the estimated Unified classes were used. The limitations were estimated assuming that the roads would be surfaced. On unsurfaced roads, rapidly drained, very sandy, poorly graded soils may cause washboard or rough roads.

[6] Group index values were estimated from information published by the Portland Cement Association (PCA, 1962) pp. 23-25.

[7] Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30 percent.

[8] P.I. means plasticity index.

[9] Frost heave is important where frost penetrates below the paved or hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The susceptibility classes are taken from the United States Army Corps of Engineers (1962) pp. 5-8.

TABLE 17

Guide for Assessing Soil Suitability for Trench-Type Sanitary Landfills

The trench-type sanitary landfill is a sanitary landfill, in which dry garbage and trash is buried daily in an open trench and covered with a layer of soil material. Suitability of the site is dependent upon the potential for pollution of water sources through groundwater contact with the refuse, or leachate arising from the site. Those properties affecting ease of excavation of the site must be supplemented with geological and hydrological knowledge to provide subsurface soil and groundwater data to a depth of at least 3 to 4.5 m, a common depth of landfills.

Symbol[2]	Items Affecting Use	Degree of Soil Suitability			
		Good - G[3]	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal High Water Table	Not class determining if more than 180 cm		100-180 cm	<100 cm
w	Wetness[4]	Not class determining if better than imperfectly drained		Imperfectly drained	Poorly and very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[5]	<5 cm/hr	<5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-15%	15-30%	30-45%	>45%
s	Soil Texture[4],[6] (dominant to a depth of 150 cm)	SL, L, SiL, SCL	SiCL[7], CL, SC, LS	SiC, C	Muck, peat, gravel, sand
d	Depth to Hard Bedrock Rippable	>150 cm >150 cm	>150 cm 100-150 cm	100-150 cm 100-150 cm	<100 cm <100 cm
p	Stoniness[4]	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones <0.1 m apart (Class 5)
r	Nature of Bedrock	Impermeable			Highly permeable, fractured, easily soluble

---

[1] Based on soil depth (120 cm) commonly investigated in making soil surveys.

[2] The symbols are used to indicate the nature of the limitation.

[3] If probability is high that the soil material to a depth of 3 to 4.5 m will not alter a rating of good or fair, indicate this by an appropriate footnote, such as "Probably good to a depth of 3.5 m", or "Probably fair to a depth of 3.5 m".

[4] For an explanation of stoniness, texture and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Reflects ability of soil to retard movement of leachate from the landfills; may not reflect a limitation in arid and semiarid areas.

[6] Reflects ease of digging and moving (workability) and trafficability in the immediate area of the trench where there may not be surfaced roads.

[7] Soils high in expansive clays may need to be given a suitability rating of poor.

TABLE 18

Guide for Assessing Soil Suitability for Area-Type Sanitary Landfills

In the area-type sanitary landfill refuse is placed on the surface of the soil in successive layers. The daily and final cover material generally must be imported. A final cover of soil material at least 60 cm thick is placed over the fill when it is completed.

The soil under the proposed site should be investigated so as to determine the probability that leachates from the landfill can penetrate the soil and thereby pollute water supplies.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Seasonal Water Table[2]	> 150 cm	150-100 cm	50-100 cm	<50 cm
w	Wetness[2],[3]	Rapid to moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained or permanently wet soils
i	Flooding	None	Rare	Occasional	Frequent
k	Permeability[4],[5]	Not class determining if less than 5 cm/hr		5-15 cm/hr	>15 cm/hr
t	Slope	0-9%	9-15%	15-30%	>30%

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[1] The symbols are used to indicate the nature of the limitation.

[2] Reflects influence of wetness on operation of equipment.

[3] For an explanation of drainage, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[4] Reflects ability of the soil to retard movement of leachate from landfills; may not reflect a limitation in arid and semiarid areas.

[5] Due to possible groundwater contamination, impermeable bedrock is considered poor and permeable bedrock is rated very poor for area-type sanitary landfills.

TABLE 19

Guide for Assessing Soil Suitability as Cover Material for Area-Type Sanitary Landfills

The term cover material includes soil materials used to put a daily and final covering layer on refuse in area-type sanitary landfills. This cover material may be derived from the area of the landfill or may be brought in from surrounding areas.

Symbol1/	**Items Affecting Use**	**Degree of Soil Suitability**			
		Good - G	**Fair - F**	**Poor - P**	**Very Poor - V**
u	**Moist Consistence2/**	**Very friable, friable**	**Loose, firm**	**Very firm**	**Cemented**
s	**Texture2/,3/**	SL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C	**Muck, peat, sand, gravel**
d	**Depth to bedrock4/**	**>150 cm**	**100-150 cm**	**50-100 cm**	**<50 cm**
c	**Coarse fragments2/**	**<15%**	**15-35%**	**>35%**	
p	**Stoniness2/**	**Stones >10 m apart (Class 0 and 1)**	Stones 2-10 m apart (Class 2)	**Stones 0.1-2 m apart (Class 3 and 4)**	**Stones <0.1 m apart (Class 5)**
t	**Slope**	**<9%**	**9-15%**	**15-30%**	**>30%**
w	**Wetness2/**	**Not class determining if better than poorly drained**		**Poorly drained**	**Very poorly drained or permanently wet soils**

1/ The symbols are used to indicate the nature of the limitation.

2/ For an explanation of consistence, texture, coarse fragments, stoniness and soil drainage classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Soils having a high proportion of non-expansive clays may be given a suitability rating one class better than is shown for them in this table.

4/ Thickness of material excluding topsoil, which will be stockpiled (see guide for topsoil).

TABLE 20

Guide for Assessing Soil Suitability for Reservoirs and Sewage Lagoons

Factors affecting the ability of undisturbed soils to impound water or sewage and prevent seepage are considered for evaluating soils on their suitability for reservoir and lagoon areas. This evaluation considers soil both as a vessel for the impounded area and as material for the enclosing embankment. As the impounded liquids could be potential sources of contamination of nearby water supplies, e.g. sewage lagoons, the landscape position of the reservoir as it affects risk of flooding must also be considered.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
h	Depth to Water Table[2]	>150 cm	100-150 cm	50-100 cm	<50 cm
i	Flooding[3]	None	None	Subject to infrequent flooding (once in 50 years)	Subject to frequent high level flooding
k	Soil Permeability	0-0.5 cm/hr	0.5-5 cm/hr	5-15 cm/hr	>15 cm/hr
t	Slope	0-2%	2-5%	5-9%	>9%
o	Organic Matter	<2%	2-10%	10-30%	>30%
c	Coarse Fragments[4] <25 cm in diameter, % by volume	<20%	20-35%	>35%	
p	Stoniness[4], >25 cm diameter, percent of surface area	<3% (Class 0, 1 and 2)	3-15% (Class 3)	15-50% (Class 4)	>50% (Class 5)
d	Depth to Bedrock[5]	>150 cm	100-150 cm	50-100 cm	<50 cm
j	Thickness of Slowly Permeable Layer	>100 cm	50-100 cm	50-25 cm	<25 cm
a	Subgrade [6] Unified Soil Classes	GC, SC, CL, & CH	GM, ML, SM & MH	SW & SP	OL, OH & Pt GP, GW

---

[1] The symbols are used to indicate the nature of the limitation.

[2] If the floor of the lagoon has nearly impermeable material at least 50 cm thick, disregard depth to water table.

[3] Disregard flooding if it is not likely to enter or damage the lagoon (flood waters have low velocity and depth less than 150 cm).

[4] For an explanation of coarse fragments and stoniness classes, see the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Surface exposures of non rippable rock are rated very poor. If underlying bedrock is impermeable, rating should be one class better.

[6] The materials listed under Good would probably meet the hydraulic conductivity of less than 10^{-7} cm/sec upon layering and adequate compaction.

TABLE 21

Guide for Assessing Soil Suitability for Septic Tank Absorption Fields

This guide applies to soils to be used as an absorption and filtering medium for effluent from septic tank systems. A subsurface tile system laid in such a way that effluent from the septic tank is distributed reasonably uniformly into the natural soil is assumed when applying this guide. A rating of poor need not mean that a septic system should not be installed in the given soil, but rather, may suggest the difficulty, in terms of installation and maintenance, which can be expected.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
k	Permeability[2]	Rapid to moderately rapid	Moderate	Slow	Very slow
	Percolation Rate[3] (Auger hole method)	About 8-18 min/cm[3]	18-24 min/cm	Slower than 24 min/cm	
h	Depth to Seasonal Water Table[4]	>150 cm[5]	100-150 cm	50-100 cm	<50 cm
i	Flooding	Not subject to flooding	Not subject to flooding	Subject to occasional flooding (once in 5 years)	Floods every year
t	Slope	0-9%	9-15%	15-30%	>30%
d	Depth to Hard Rock, bedrock or other impervious materials	>150 cm	100-150 cm[6]	50-100 cm	<50 cm

[1] The symbols are used to indicate the nature of the limitation.

[2] The suitability ratings should be related to the permeability of soil layers at and below depth of the tile line.

[3] Soils having a percolation rate less than about 8 min/cm are likely to present a pollution hazard to adjacent waters. This hazard must be noted, but the degree of hazard must, in each case, be assessed by examining the proximity of the proposed installation to water bodies, water table, and related features. The symbol g is used to indicate this condition. Refer to U.S. Dept. of Health, Education and Welfare (1969) for details of this procedure.

[4] Seasonal means for more than one month. It may, with caution, be possible to make some adjustment for the severity of a water table limitation in those cases where seasonal use of the facility does not coincide with the period of high water table.

[5] A seasonal water table should be at least 100 cm below the bottom of the trench at all times for soils rated Good (U.S. Dept. of Health, Education and Welfare, 1969). The depths used to water table are based on an assumed tile depth of 50 cm. Where relief permits, the effective depth above a water table or rock can be increased by adding appropriate amounts of fill.

[6] Where the slope is greater than 9%, a depth to bedrock of 100-150 cm is assessed as poor.

TABLE 22

Comparison of Soil Particle Sizes for the USDA, Unified and AASHO Systems for Textural Classifications Commonly Used in Canada

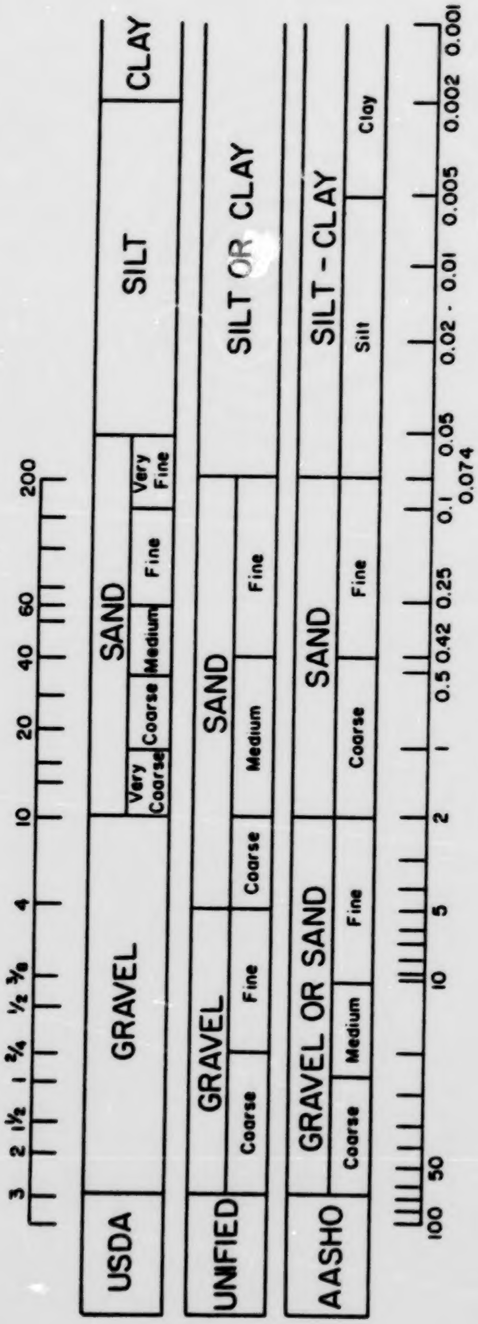


TABLE 23

Frost Design Soil Classification

Frost Group	Kind of Soil	Percentage, by weight, finer than 0.02 mm	Typical Soil Types Under Unified Soil Classification System
F1	Gravelly soils	3 to 10	GW, GP, GW-GM, GP-GM
F2	(a) Gravelly soils	10 to 20	GM, GW-GM, GP-GM
	(b) Sands	3 to 15	SW, SP, SM, SW-SM, SP-SM
F3	(a) Gravelly soils	Over 20	GM, GC
	(b) Sands, except very fine silty sands	Over 15	SM, SC
	(c) Clays, PI >12		CL, CH
F4	(a) All silts		ML, MH
	(b) Very fine silty sands	Over 15	SM
	(c) Clays, PI <12		CL, CL-ML
	(d) Varved clays and other fine-grained, banded sediments		CL and ML; CL, ML and SM; CL, CH and ML; CL, CH, ML and S

Note: Taken from the United States Army Corps of Engineers, 1962.

TABLE 24

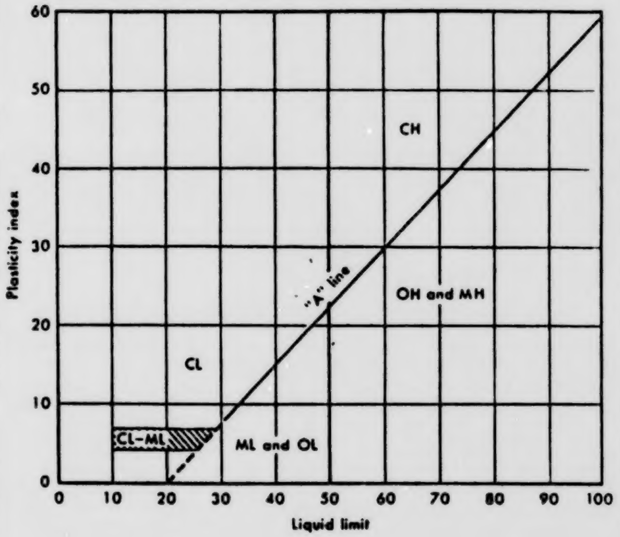
Classification of Highway Subgrade Materials (with suggested subgroups)

General classification	Granular materials (35% or less passing No. 200)							Silt-clay materials (More than 35% passing No. 200)			
Group classification	A-1		A-3	A-2				A-4	A-5	A-6	A-7
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5 A-7-6
Sieve analysis, percent passing:											
No. 10	50 max.	-	-	-	-	-	-	-	-	-	-
No. 40	30 max.	50 max.	51 min.	-	-	-	-	-	-	-	-
No. 200	15 max.	25 max.	10 max.	35 max.	35 max.	35 max.	35 max.	36 min.	36 min.	36 min.	36 min.
Characteristics of fraction passing No. 40:											
Liquid limit	-		-	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Plasticity index	6 max.		NP	10 max.	10 max.	11 min.	11 min.	10 max.	10 max.	11 min.	11 min.*
Group Index	0		0	0		4 max.		8 max.	12 max.	16 max.	20 max.
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to good					Fair to poor					

* Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.

TABLE 25

Unified Soil Classification System

Major divisions			Group symbols		Typical names	Laboratory classification criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent ...... GW, GP, SW, SP More than 12 per cent ...... GM, GC, SM, SC 5 to 12 per cent ...... Borderline cases requiring dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM*	d	Silty gravels, gravel-sand-silt mixtures		Atterburg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are border line cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterburg limits above "A" line with P.I. greater than 7.	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 1	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM*	d	Silty sands, sand-silt mixtures		Atterburg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterburg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	 Plasticity Chart		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt		Peat and other highly organic soils			

*Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterburg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

**Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

TABLE 26

Guide for Assessing Soil Suitability for Playgrounds

This guide applies to soils to be used intensively for playgrounds for baseball, football, badminton, and for other similar organized games. These areas are subject to intensive foot traffic. A nearly level surface, good drainage, and a soil texture and consistence that gives a firm surface generally are required. The most desirable soils are free of rock outcrops and coarse fragments.

Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2]	Rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding of short duration and imperfectly drained soils. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding, and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	Occasional flooding. May flood once every 2-3 years during season of use.	Floods every year during season of use.	Prolonged flooding during season of use.
k	Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.	
t	Slope	0-2%	2-5%	5-9%	>9%
d	Depth to Bedrock	>100 cm	50-100 cm[3]	<50 cm[3]	
c	Coarse fragments on surface[2]	Relatively free of coarse fragments.	<20% coarse fragments.	>20% coarse fragments.	
p	Stoniness[2]	Stones >10 m apart. (Class 0 to 1)	Stones 2-10 m apart. (Class 2)	Stones 0.1-2 m apart. (Class 3, 4)	Stones <0.1 m apart. (Class 5)
r	Rockiness[2]	Rock exposures >100 m apart and cover <2% of the surface.	Rock exposures 30-100 m apart and cover about 2-10% of the surface.	Rock exposures <30 m apart and cover >10% of the surface.	Rock outcrops too frequent to permit playground location.
s	Surface Soil Texture[2],[4]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS	SC, SiC, C[5]; S, Si	Peaty soils; S and LS subject to blowing.
q	Depth to Sand or Gravel[6]	>100 cm	50-100 cm	<50 cm	
m	Useful Moisture[7]	Water storage capacity[8] >15.0 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

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[1] The symbols are used to indicate the nature of the limitation.

[2] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).
Coarse fragments for the purpose of this table include gravels and cobbles.

[3] Downgrade to a very poor suitability rating if the slope is greater than 5%.

[4] Surface soil texture influences soil ratings as it affects foot trafficability, surface wetness, dust, and maintenance. Adverse soil textures may be partially or completely overcome with the addition of topsoil.

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Depth to sand or gravel is considered a limitation in that levelling operations may expose sand or gravel, thereby bringing about adverse surface textures and undesirable amounts of coarse fragments. The addition of topsoil after the levelling process would overcome this limitation.

[7] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8] Consult glossary for definitions of terms used.

TABLE 27

Guide for Assessing Soil Suitability for Camp Areas

This guide applies to soils to be used intensively for tents and camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic by humans and limited vehicular traffic. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of site.

Back country campsites differ in design, setting and management but require similar soil attributes. These guides should apply to evaluations for back country campsites but depending on the nature of the facility the interpreter may wish to adjust the criteria defining a given degree of limitation to reflect the changed requirement. For example, small tentsites may allow rock exposures greater than 10 m apart to be considered a slight limitation.

Symbol1/	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness2/	Very rapidly, rapidly, well and moderately well drained soils with no seepage or ponding. Water table below 75 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils with no seepage or ponding. Water table below 50 cm during season of use.	Imperfectly drained soils subject to seepage or ponding and poorly drained soils. Water table above 50 cm during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None	Very occasional flooding during season of use. Once in 5-10 years.	Occasional flooding during season of use. Once in 2-4 years.	Flooding during every season of use.
k	Permeability	Very rapid to moderate inclusive.	Moderately slow and slow.	Very slow.	
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture2/,3/	SL, FSL, VFSL, L	SiL, SCL, CL, SiCL, LS, and sand other than loose sand.	SC, SiC, C4/; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface2/,5/	0-20%	20-50%	>50%	
p	Stoniness2/,6/	Stones >10 m apart (Class 0 and 1)	Stones 2-10 m apart (Class 2)	Stones 0.1-2 m apart (Class 3 and 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness2/,6/	No rock exposures	Rock exposures >10 m apart and cover <25% of the area.	Rock exposures <10 m apart and cover >25% of the area.	Rock exposures too frequent to permit campground location.

1/ The symbols are used to indicate the nature of the limitation.

2/ See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

3/ Surface soil texture influences soil ratings as it affects foot trafficability, dust, and soil permeability.

4/ Moderately well and well drained SC, SiC and C soils may be rated fair.

5/ Coarse fragments for the purpose of this table include gravels and cobbles. Some gravelly soils may be rated as having slight limitations if the content of gravel exceeds 20% by only a small margin, providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

6/ Very shallow soils are rated as having a limitation for rockiness and/or stoniness.

TABLE 28

Guide for Assessing Soil Suitability for Picnic Areas

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to the access roads. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Symbol[1/]	Items Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
w	Wetness[2/]	Very rapidly, rapidly, well and moderately well drained soils not subject to seepage or ponding. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage or ponding and imperfectly drained soils not subject to ponding or seepage. Water Table above 50 cm for short periods during season of use.	Imperfectly drained soils subject to seepage or ponding. Poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Very poorly drained and permanently wet soils.
i	Flooding	None during season of use.	May flood 1 or 2 times per year for short periods during season of use.	Floods more than 2 times during season of use.	Prolonged flooding during season of use.
t	Slope	0-9%	9-15%	15-30%	>30%
s	Surface Soil Texture[2/],[3/]	SL, FSL, VFSL, L	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C[4/]; Si	Peaty soils; loose sand subject to blowing.
c	Coarse Fragments on Surface[2/]	0-20%	20-50%	>50%	
p	Stoniness[2/]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones < 0.1 m apart (Class 5)
r	Rockiness[2/],[5/],[6/]	Rock exposures roughly 30-100 or more m apart and cover < 10% of the surface.	Rock exposures roughly 10-30 m apart and cover 10-25% of the surface.	Rock exposures < 10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of picnic areas.
m	Useful Moisture[7/]	Water storage capacity[8/] >15 cm and/or adequate rainfall and/or low evapotranspiration.	Water storage capacity[8/] 7.5-15 cm and/or moderate rainfall and/or moderate evapotranspiration.	Water storage capacity[8/] <7.5 cm and/or low rainfall and/or high evapotranspiration.	

[1/] The symbols are used to indicate the nature of the limitation.

[2/] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978). Coarse fragments for the purpose of this table, include gravels and cobbles. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 2 cm in size.

[3/] Surface soil texture influences soil ratings as it affects foot trafficability, dust and soil permeability.

[4/] Moderately well and well drained SC, SiC and C soils may be rated fair.

[5/] Very shallow soils are rated as having severe or very severe limitations for stoniness or rockiness.

[6/] The nature and topography of the bedrock exposures may significantly alter these ratings. As such, on-site investigations will be necessary in map units containing bedrock when these are considered as possible sites.

[7/] This item attempts to evaluate the adequacy of moisture for vegetative growth. It incorporates the concept of supply through rainfall, loss through evapotranspiration, and storage within the rooting zone. In soils where the water table is within rooting depth for a significant portion of the year, water storage capacity may not significantly influence vegetation growth.

[8/] Consult glossary for definitions of terms used.

TABLE 29

Guide for Assessing Soil Suitability for Paths and Trails

It is assumed that the trails will be built at least 45 cm wide and that obstructions such as cobbles and stones will be removed during construction. It is also assumed that a dry, stable tread is desirable and that muddy, dusty, worn or eroded trail treads are undesirable. Hiking and riding trails are not treated separately, but as the design requirements for riding trails are more stringent, a given limitation will be more difficult to overcome. Poor or very poor suitability does not indicate that a trail cannot or should not be built. It does, however, suggest higher design requirements and maintenance to overcome the limitations.

Symbol[1]	Items[2] Affecting Use	Degree of Soil Suitability			
		Good - G	Fair - F	Poor - P	Very Poor - V
s	Texture[3],[4]	SL, FSL, VFSL, LS, L	SiL, CL, SiCL, SCL	SC, SiC, C[5]; Sand, Si	Peaty soils; loose sand subject to blowing
c	Coarse Fragment Content[4],[6]	0-20%	20-50%	>50%	
p	Stoniness[4]	Stones >2 m apart (Class 0 to 2)	Stones 1-2 m apart (Class 3)	Stones 0.1-1 m apart (Class 4)	Stones <0.1 m apart (Class 5)
w	Wetness[4]	Very rapidly, rapidly well, and moderately well drained soils. Water table below 50 cm during season of use.	Moderately well drained soils subject to occasional seepage and ponding and imperfectly drained soils. Water table may be above 50 cm for short periods during season of use.	Poorly and very poorly drained soils. Water table above 50 cm and often near surface for a month or more during season of use.	Permanently wet soils.
r	Rockiness[4],[7]	Rock exposures >30 m apart and cover <10% of the surface.	Rock exposures 10-30 m apart and cover 10-25% of the surface.	Rock exposures <10 m apart and cover >25% of the surface.	Rock exposures too frequent to permit location of paths and trails.
t	Slope[8]	0-15%	15-30%	30-60%	>60%
i	Flooding	Not subject to flooding during season of use.	Floods 1 or 2 times during season of use.	Floods more than 2 times during season of use.	Subject to prolonged flooding during season of use.

---

[1] The symbols are used to indicate the nature of the limitation.

[2] The items affecting use listed in this table are those which have been shown to cause significant differences in trail response. Elevation, aspect, position on slope, and snow avalanching may have slight effects or influence trail management and should be considered in the final site evaluation. Items such as vegetation, fauna, and scenic value are not considered in the guidelines (Epp, 1977).

[3] Texture refers to the soil texture which will form the tread texture. This is the surface texture on level areas but may be a subsurface texture on slopes. Textural classes are based on the less than 2 mm soil fraction. Texture influences soil ratings as it influences foot trafficability, dust, design or maintenance of trails, and erosion hazards.

[4] See also definitions for coarse fragments, rockiness, stoniness, textural and soil drainage classes in the Manual for Describing Soils in the Field (Canada Soil Survey Committee, 1978).

[5] Moderately well and well drained SC, SiC and C soils may be rated fair.

[6] Coarse fragments for the purpose of this table, include gravels and cobbles. Gravels tend to cause unstable footing when present in high amounts, and are also associated with increased erosion. Cobbles (and stones) must be removed from the trail tread, increasing construction and maintenance difficulties. Some gravelly soils may be rated as having a slight limitation if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 2 cm in size.

[7] The type of rock outcrop (flat lying vs cliffs), and the orientation of the structure (linear cliffs vs massive blocks) can greatly alter the degree of the limitation. Each site with a Rockiness limitation based on the percent rock outcrop above should be evaluated on its own merits and the degree of limitation should then be modified appropriately if necessary.

[8] Slope in this context refers to the slope of the ground surface, not the slope of the tread.

Appendix E

CORRELATION OF THE SOILS OF THE SHELLMOUTH RESERVOIR NORTH STUDY AREA WITH THE SOILS AS DESCRIBED IN THE SOIL SURVEY OF THE GRANDVIEW MAP SHEET, REPORT NO. 9, 1959

This soil study replaces that portion of the 1959 reconnaissance soil survey of the Grandview area, occurring in the vicinity of the Assiniboine River in Shell River Municipality. This resurvey benefits from advantages derived from more intensive examination of the soils in the field, use of larger mapping scale to permit delineation of numerous important local soils, use of modern aerial photographs and use of improved methods of studying soils in the laboratory.

The present detailed soil map differs substantially from the 1959 Grandview reconnaissance map; the major difference between them is the scale and degree of detail shown.

In the reconnaissance map of the Grandview Sheet, each map unit consists of a complex of soil types known as a "soil association", having a dominant soil type interspersed with related but unlike local soil types in lesser proportion. While soil associations are shown as units on the reconnaissance map, local associated soils and textural classes are occasionally mapped and designated as separate units where the areas involved are substantial or where such units are of sufficient local importance. These individual associated soils, developed on similar kinds of soil parent material, are referred to as "soil associates". They are recognized by differences in their soil profile characteristics as a result of differences in topographic position, which in turn affects drainage and soil climate, often over short intervals in the same field. For example, on hummocky glacial till in the Black soil zone in the Grandview Sheet, the prevailing well drained crest position will have Calcareous Blacks, upper and intermediate slopes as Orthic Blacks; the soils on lower slopes may be Gleyed Eluviated Black, while in the depression, leached Luvic Humic Gleysols. Each of these soils developed on the same geologic deposit will show different profile characteristics when examined in cross section.

In the present detailed map, each unit is either a simple unit consisting of a single soil type referred to as a 'soil series' or a specifically defined compound unit containing one dominant soil series and one other related by unlike soil series associated with it. Soil series in terms of current Canadian Soil Classification criteria (CSSC, 1978) are approximately equivalent to soil associates as defined in the 1959 study. In general, the range in allowable variation in profile characteristics and properties of soil series is significantly less than the range in the former 'soil associates'. In this study, these more specifically defined soil series are also grouped in more narrowly defined soil associations to accommodate field classification. Correlation with the 1959 study is provided (Table 30).

TABLE 30

Correlation of the Soil Series of the Shellmouth Reservoir North Study Area with the Soil Associations of the Grandview Map Sheet, Report No. 9, 1959

Soil Symbol	Series Name	Subgroup	Present Association	Soil Associations and Associates of the Grandview Map Sheet
ASB	Assiniboine	Gleyed Cumulic Regosol	Assiniboine	Assiniboine Complex, immature soils, imperfectly drained on recent alluvium, clayey sediments.
BEO	Benton	Solonetzic Dark Gray	Benton	Not mapped in Grandview sheet; correlates with Benton Association in the Rossburn-Virden Map Sheet (1956) as Solonetz to Solod type on shale clay.
BKR	Basker	Rego Humic Gleysol	Levine	Assiniboine Complex, immature soils, poorly drained, stratified sandy loam to clay loam.
DVD	Davidson	Orthic Dark Gray	Davidson	Onanole Association; correlates with the Onanole Sandy Loam which were Gray Black soils on moderately coarse textured sediments. (included the sandy soils).
ECK	Erickson	Orthic Dark Gray	Erickson	Erickson Association, Degraded Black Associate (no change from 1959).
FTN	Fortina	Rego Humic Gleysol	Marringhurst	Marringhurst Association, Orthic or Peaty Meadow, poorly drained.
JAY	Jaymar	Orthic Black	Jaymar	Newdale Modified, Orthic Black Associate, well drained.
LEI	Levine	Gleyed Cumulic Regosol	Levine	Assiniboine Complex, immature soils, imperfectly drained, sandy loam to clay loam textures.
LGD	Longdens	Gleyed Eluviated Black	Jaymar	Newdale Modified, Gleyed Degraded Black Associate, imperfectly drained.
LRY	Leary	Orthic Dark Gray	Leary	Leary Association, Degraded Black Associate (no change from 1959).

Table 30 (cont'd)

Soil Symbol	Series Name	Subgroup	Present Association	Soil Associations and Associates of the Grandview Map Sheet
MOW	Mowbray	Cumulic Regosol	Levine	Assiniboine Complex, immature to weakly developed flood plain soils, moderately well drained, sandy loam to silty clay loam.
MRH	Marringhurst	Calcareous Black	Marringhurst	Marringhurst Association, Thin Black Associate, well drained.
NDL	Newdale	Orthic Black	Newdale	Newdale Association, Orthic Black Associate, well drained.
OZA	Ozerna	Orthic Dark Gray	Ozerna	Erickson modified, Degraded Black Associate, well drained.
PEN	Penrith	Humic Luvic Gleysol	Newdale	Newdale Association, Orthic Meadow (Grey Wooded Gley) Associate, poorly drained.
RBN	Roblin	Humic Luvic Gleysol	Erickson	Erickson Association, Grey Wooded Gley Associate, poorly drained.
SZR	St. Lazare	variable		Eroded Slopes Complex; dominantly well to excessively drained with minor seepage areas.

Appendix F

INTERPRETATION OF THE SOIL AND LANDSCAPE PROPERTIES WITHIN THE ASSINIBOINE VALLEY FOR SLOPE STABILITY

Soil and Landscape Conditions

Most of the soils within the Assiniboine River Valley in proximity of the Shellmouth Reservoir N have been mapped as the St. Lazare Complex. This complex is characterized by mass wasting features and soil profiles that are weakly to well developed. Soil parent materials vary in texture and composition and their distribution varies with slope and position. Although the materials are variable, they have been segregated into five groups which key on either the dominance of a particular texture or a combination of two or more textures. Additional separations of this soil complex have been based on complexity and steepness of the slopes.

Based on present conditions and soil development, it appears that the valley walls have maintained their stability for a considerable period of time; no recent slump or failures have been noted during the study, except localized areas along the shoreline. This indicates that, under the present land use and vegetative conditions, the area is maintaining its stability. However, since the area had experienced mass wasting in the past, the potential for mass movement and surface erosion could be high should development activities such as clearing, road building or residence construction with septic systems encroach on sloping lands.

Mass Wasting of Valley Sidewalls

Mass wasting is a collective term for all gravitational or downslope movements of weathered rock debris (Bloom 1978). Although flowing water is excluded from the process by definition, water nevertheless plays an important role by oversteepening slopes through surface erosion at their bases and by generating seepage forces through groundwater flow (often referred to as "lubrication of rock or weathered rock debris on a slope".

Various types of classifications of mass wasting have been described depending on the discipline. The term slope movement is commonly used in engineering and refers to the downward and outward movement of any slope forming materials such as bedrock, rock debris and earth (fine grained fragmental debris).

Most of the features along the Assiniboine valley could be considered as a slide where weathered and former depositional materials moved downhill along discrete shear faces. The slump is a specific type of slide where the surface of failure beneath the soil mass that moved (slump block) is spoon shaped, concave upward or outward (Figure 9). The upper surface of the slump block is tilted backward (toward the steep main scarp or wall), because the entire mass rotates as the lower part moves outward and downhill. At the time of failure, the soil mass may move as single blocks (Figures 10, 11) or smaller independent units as multiple slices (Figures 12, 13) that vary in appearance from a saw-tooth pattern to somewhat rounded step-like "terracettes". Ponds often form at the angle between the base of a slump scar and the former head or top of a rotated slump block.

These features are considered to be classic examples and generally could be easily recognized. However, along the valley walls of the Assiniboine River, these slide features generally are not as distinct or obvious. The upper crests of most of the steeper areas have been rounded and have the appearance of morainic topography with ridges, rounded knobs and depressions (Figure 14). Lower slope areas have a morainic appearance and the slopes are not as steep as in the upper part of the valley wall. Evidence of seepage is common along the valley walls and can be readily identified by the change in vegetation (Figures 11, 15). They usually have a surface peaty layer and in some of the larger units, the peat may be quite thick. The terrain surface of these seepage areas may vary from slightly sloping to moderately sloping. Underlying sediments are variable and range from sand and gravelly sand to loam or clay textures.

Shoreline Stability

Shoreline stability will contine to be a problem, particularly during periods of high water levels in the lake. The materials along the shoreline are dominantly clay and weakly weathered shale (Figures 11, 15); in many areas, the ironstones and shale flakes have provided a thin layer of coarse fragments that offer some protection against wave action. Minor slumping has occurred along the eastern shoreline where direct impact of northwesterly waves has undercut and washed the clay.

In shoreline areas with mixed parent material including till-like deposits, sufficient stones and coarse fragments have been deposited along the shore to provide protection. Only a few areas have sufficient sand and gravel to provide beach facilities.

Clay and Weathered Shale

Soils along the lower slopes of the valley are dominantly developed in clay or veneer of variably textured clay to clay loam till overlying the weathered shale. The clay soil and weathered shale have high montmorillonitic clay content with high shrink-swell properties and highly plastic consistence. It becomes very hard when dry, but has low bearing strength when wet.

The shale clay is less weathered at depths below 1.5 m. These clayey soils contain appreciable quantities of salts as indicated by electrical conductivity readings of 4 to 10 dS/M. Their chemical composition is such that they have sufficient sodium ions to cause fine clay to disperse resulting in formation of large strongly developed columnar to massive structure in the B horizons. The pH of the upper 50 cm of the profile ranges from 7.4 to 7.8, but they may have acidic subsoils with pH values lower than 5.0. The presence of iron stains, gypsum and jarosite is indicative of oxidation and weathering of sulfidic compounds such as pyrite usually found in this shaly material. Large ironstones are also common at depths of 0.7 to 1.3 m in these clayey soils, and are frequently exposed where shoreline erosion has occurred.

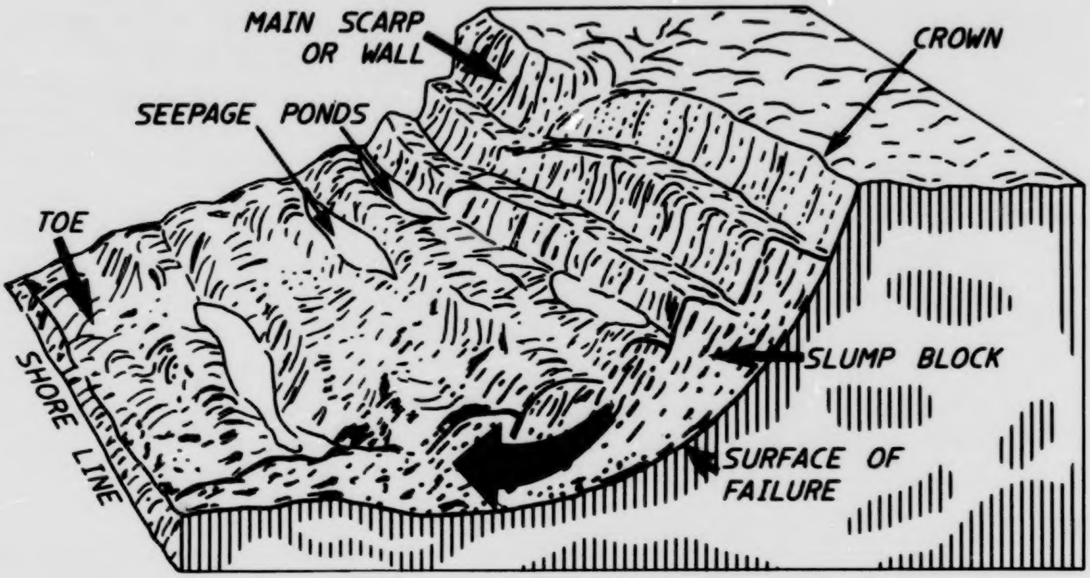

MAIN SCARP
OR WALL
CROWN
SEEPAGE PONDS
TOE
SHORE LINE
SLUMP BLOCK
SURFACE OF
FAILURE

Figure 9. Idealized sketch showing the slump-earth flow and general features characteristic of the Assiniboine Valley.

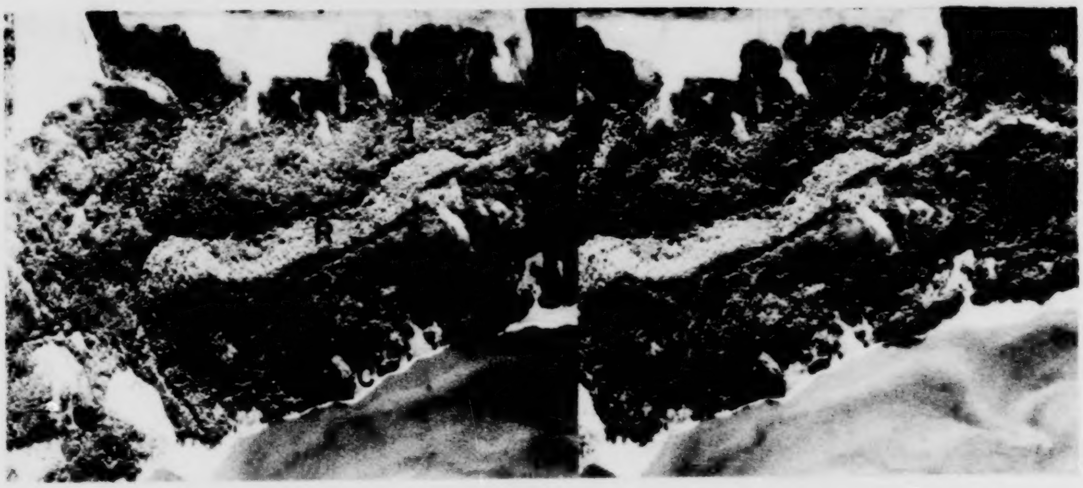


Figure 10. Prominent ridge (R) with steep sides that appear as a slide feature in the W 1/2 of 28-25-29W. The slopes along the valley wall (VW) are rounded and weakly incised; the lower slope between the wall and the ridge appears to have had considerable infilling (I). Material is dominantly till-like loams. Lower slopes (LS) have a mixture of clay, sand to gravelly sand, and till-like materials. The immediate shoreline has some clay (C) and weathered shale.

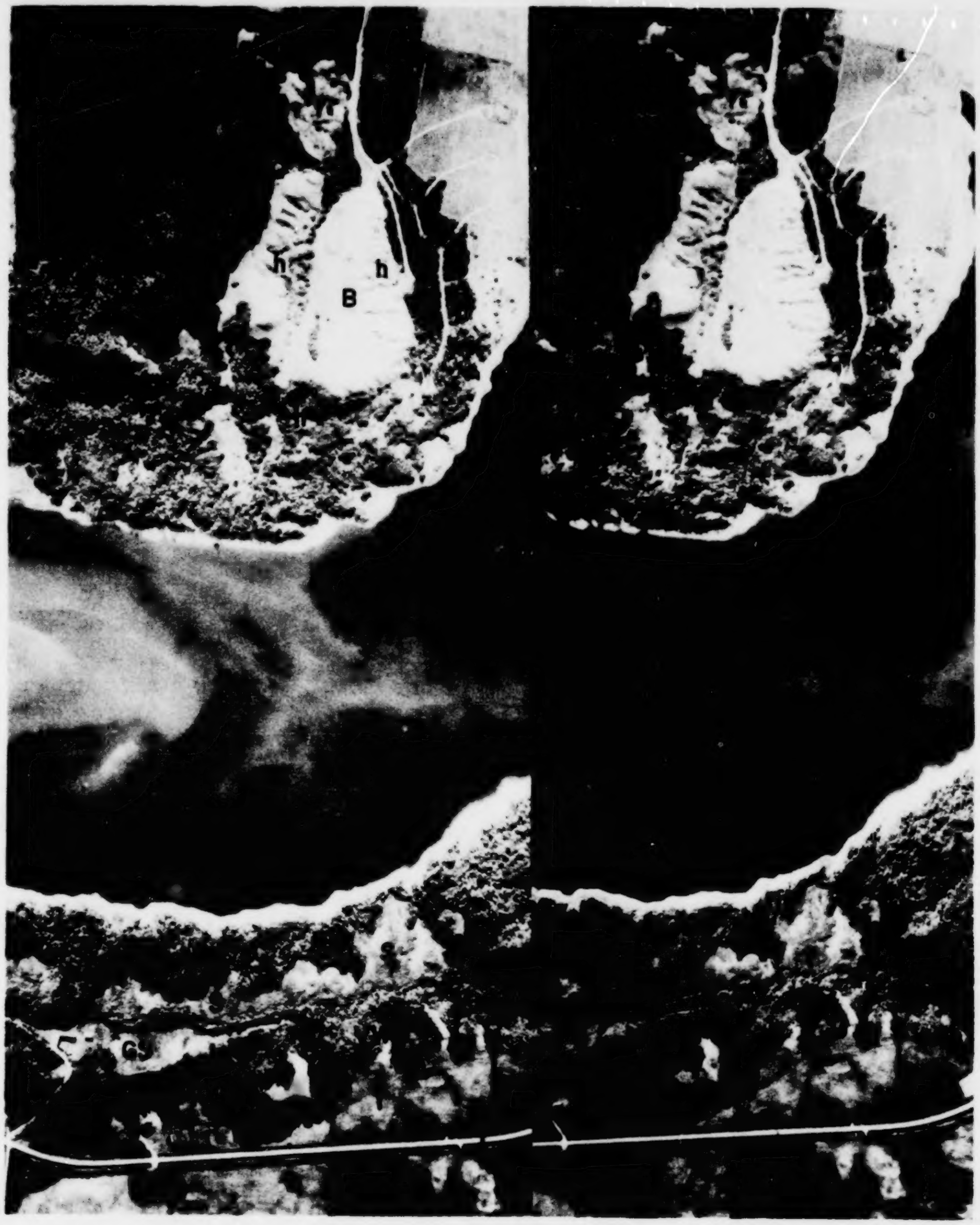


Figure 11. Landscape across the Assiniboine Valley covering parts of E 1/2 of 7 to W 1/2 of 9-25-29W. Prominant features are:

1. Slump block (B) in predominantly sand and gravelly sand materials mapped as SZR2/xcxx and steep side slopes (h) as SZR2/xhxx.
2. Naturally eroded slopes along the west side of the valley (VW) in loamy morainal till (T) of the upland.
3. Narrow sandy and gravelly (GS) sand area.
4. Large seepage area (S) at the base of the till.
5. Dominantly weakly saline clay shoreline (C) with underlying shale bedrock; slopes dominantly 5 to 9%, and moderately stony surface due to surface deposition by ice flow.

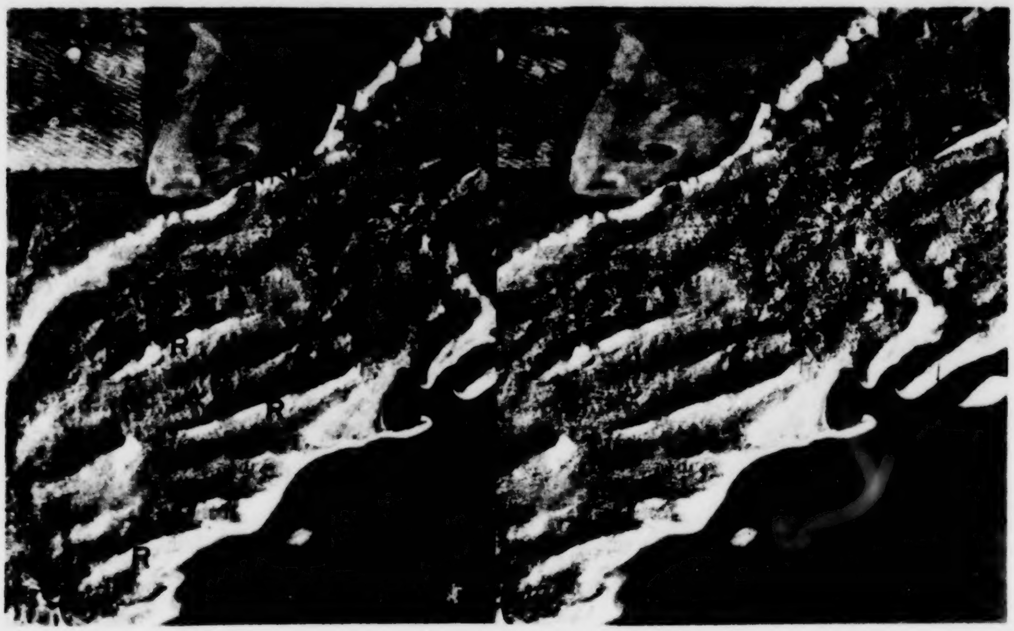


Figure 12. Multiple slump features in the SE of 2-25-29W which appear as a sequence of sharp ridges (R) in a saw-tooth pattern. Slopes along the valley wall (VW) are steep, usually greater than 70%. Upland area is morainal till (T).

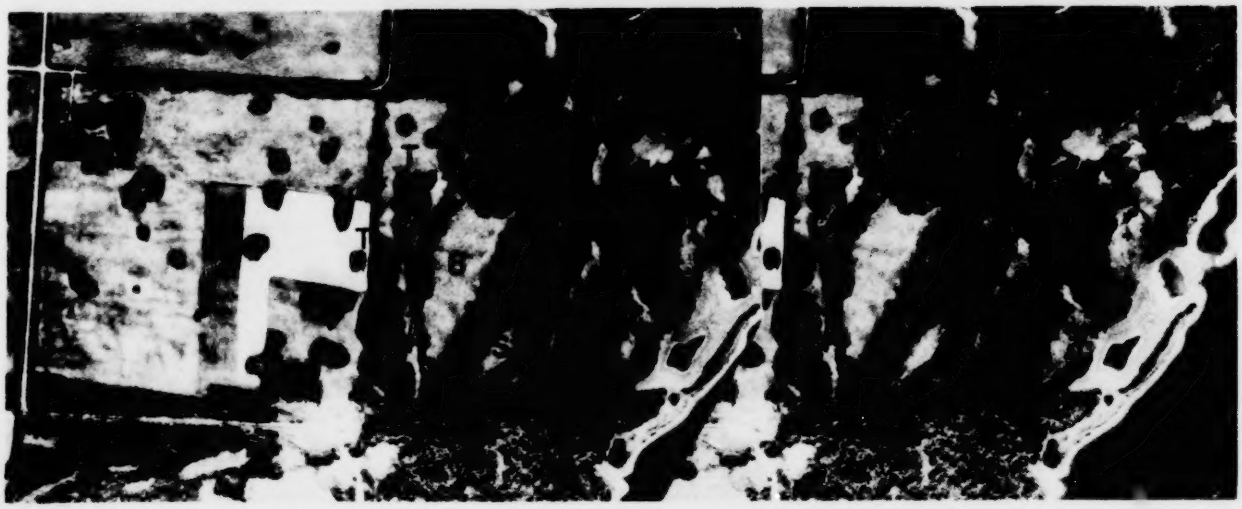


Figure 13. Landscape of the E 1/2 10-25-29W with the dominantly morainal till landscape (T) and steep scarp along the valley wall (VW) resulting from the rotational slump slide. Note the larger block slump (B); small localized ponding and seepage (S) areas occur at the base of a few slump ridges.

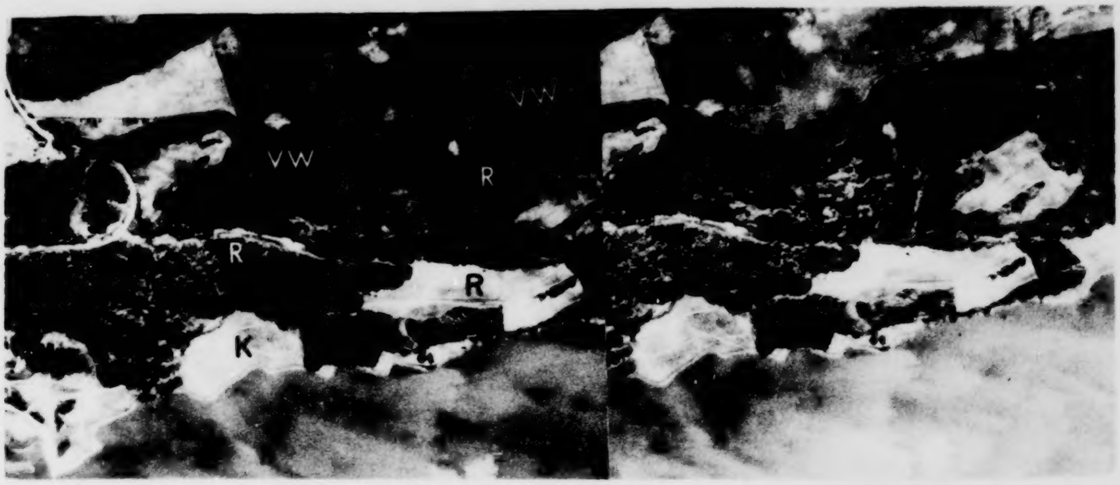


Figure 14. Landscape in W 1/2 5-26-29W with steeply sloping valley wall (VW) and variable slide features of ridges (R), hummocks and knolls (K). The materials vary in composition over short distances with sands or gravelly sands, till-like loams and clay.

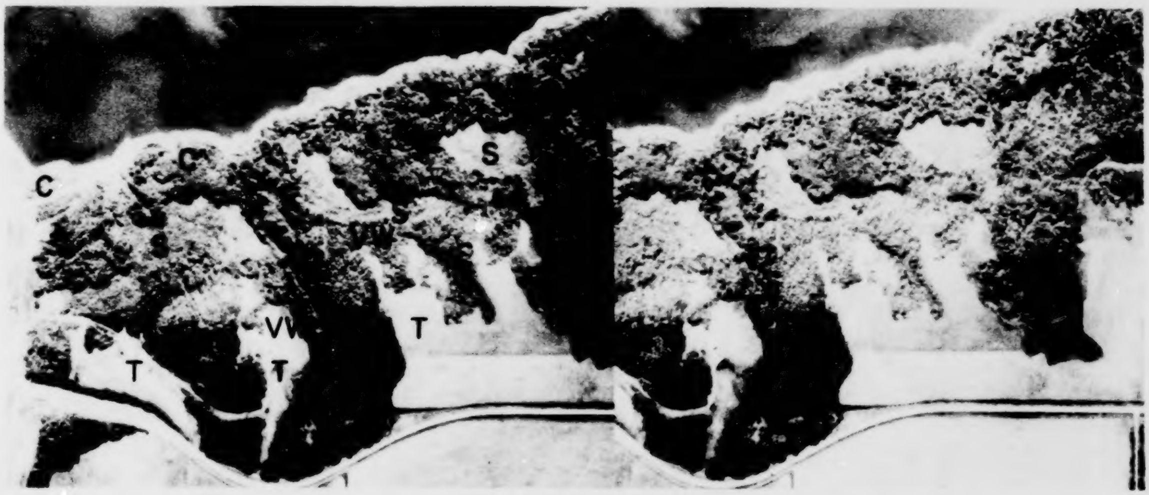


Figure 15. Landscape of W 1/2 6-26/29W with large seepage area(s) below the steeply sloping valley wall (VW). The upland is dominantly morainal till (T) with a thin loamy veneer. Side slopes are loam till or till-like material. Seepage areas have a peaty layer of variable thickness with variable underlying materials of sands or gravelly sands, till-like loams and some clay. Lower slopes are dominantly weakly saline clay (C).

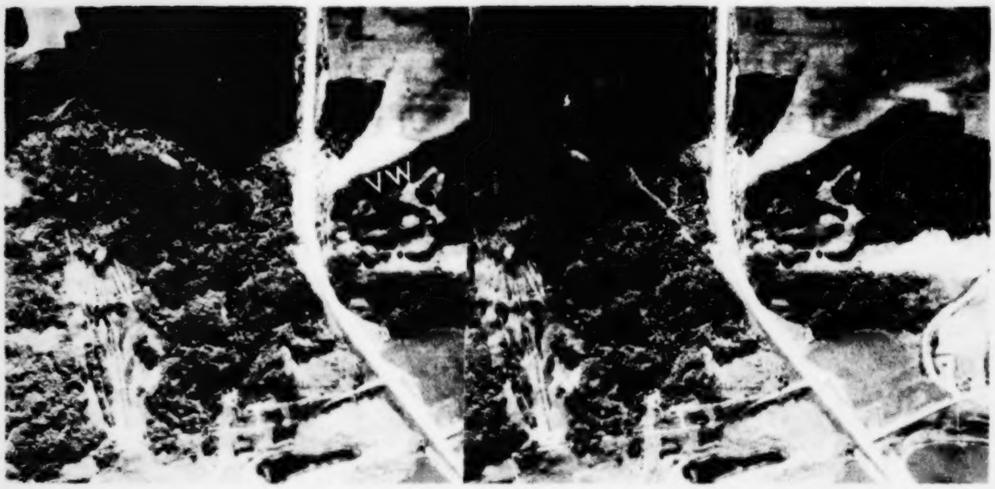
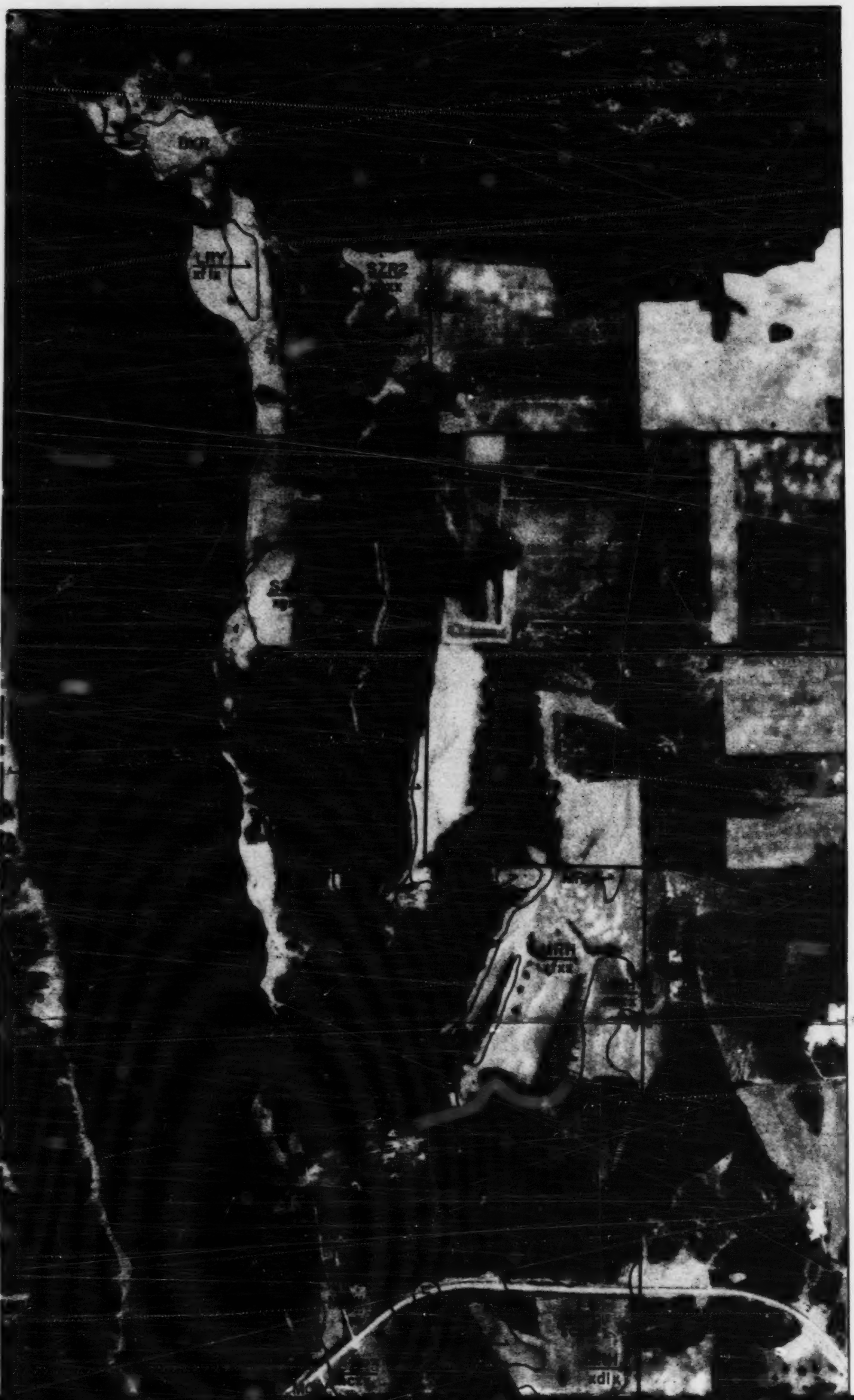


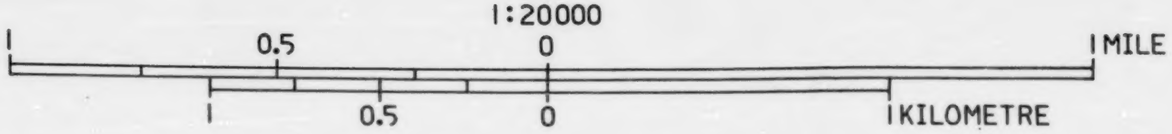
Figure 16. Landscape and land use in NE of 7, and NW 8, 26-29W with relatively steep upper valley (VW) slopes and a sequential, variable hummocky (K) to ridge-like (R) surface forms along the mid to lower slopes of the valley. Careful planning is required to maintain the stability of the area, as indicated by the highway route roads, and ski resort.

Soil Legend for SHELLMOUTH

Soil Symbol	Soil Name	Surface Texture	Soil Drainage	Mode of Deposition	Family Particle Size	Subgroup
ASB	Assiniboine	SIC	IMPER	Fluvial	Clayey	GLCU.R
BEO	Benton	C	WELL	Residual,Till/Shale		SZ.DG
BKR	Basker	SICL	POOR	Fluvial	Loamy	R.HG
BKRp	Basker	Peat	POOR	Fluvial	Loamy	R.HG
DVD	Davidson	LFS	WELL	Lacustrine	Sandy	O.DG
ECK	Erickson	L	WELL	Till	Fine Loamy	O.DG
FTN	Fortina	SL	POOR	Fluviolacustrine	Sandy Skeletal	R.HG
FTNp	Fortina	Peat	POOR	Fluviolacustrine	Sandy Skeletal	R.HG
JAY	Jaymar	L	WELL	Fluviolacustrine/Till	Loamy	O.BL
KRN	Kerran	SIC	POOR	Fluvial	Clayey	R.HG
LEI	Levine	SICL	IMPER	Fluvial	Loamy	GLCU.R
LGD	Longdens	SL	IMPER	Fluviolacustrine/Till	Loamy	GLE.BL
LRY	Leary	LS	WELL	Fluviolacustrine	Sandy Skeletal	O.DG
MHC	Marsh Complex	Peat	V.POOR	Organic	Textural Complex	R.G
MOW	Mowbray	SiCL	WELL	Fluvial	Loamy	CU.R.
MRH	Marringhurst	LS	WELL	Fluvial	Sandy Skeletal	CA.BL
NDL	Newdale	L	WELL	Till	Fine Loamy	O.BL
OZA	Ozerna	SL	WELL	Fluviolacustrine/Till	Loamy	O.DG
PEN	Penrith	L	POOR	Till	Fine Loamy	HU.LG
RBN	Roblin	L	POOR	Till	Fine Loamy	HU.LG
SZR	St. Lazare Complex	L	WELL	Colluvial	Loamy	O.DG
SZR1	St. Lazare Complex	L	WELL	Colluvial	Loamy	O.DG
SZR2	St. Lazare Complex	LS	WELL	Colluvial	Sandy Skeletal	CA.BL
SZR3	St. Lazare Complex	C	WELL	Colluvial(Residual)	Clayey	SZ.DG
SZR4	St. Lazare Complex	Var	WELL	Colluvial	Variable	O.DG,SZ.DG
SZR5	St. Lazare Complex	Peat	POOR	Organic/Colluvial	Organic/Variable	T.M,R.HG
ZZ	Water					

SOILS OF THE SHELLMOUTH RESERVOIR-NORTH AREA

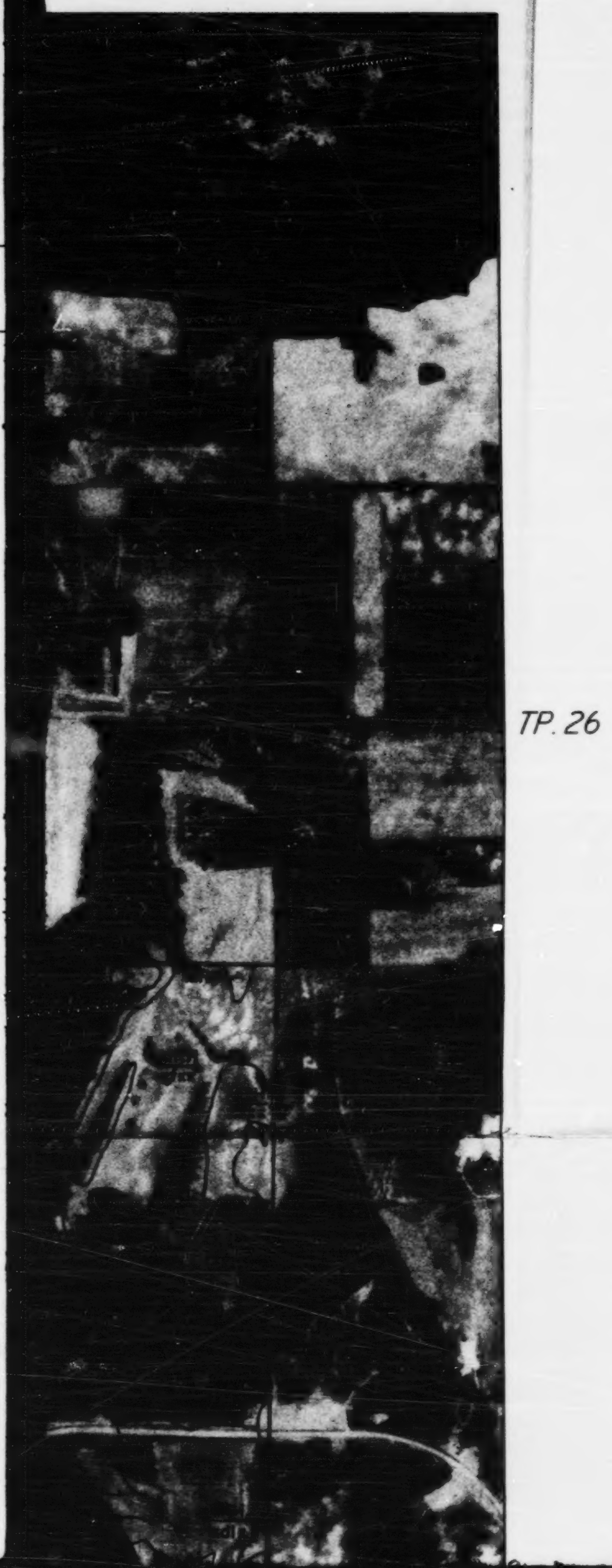


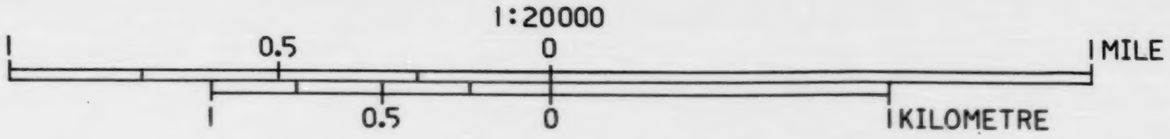


MAP LEGEND

Soil Symbol	Soil Name	Soil Drainage	Dominant Surface Texture and Parent Material	Soil Classification Subgroup
ASB	Assiniboine	Imperfect	Silty clay; stratified recent alluvial sediments of dominantly silty clay to clay.	Gleyed Cumulic Regosol
BEO	Benton	Well	Clay; weakly calcareous, slightly saline clay from weathered shale, with ironstones.	Solonetzic Dark Gray
BKR	Basker	Poor	Silty clay loam; stratified recent alluvial sediments of sandy loam to silty clay loam.	Rego Humic Gleysol
DVD	Davidson	Well	Loamy sand; weak to moderately calcareous, coarse loamy to sandy textured lacustrine deposits.	Orthic Dark Gray
ECK	Erickson	Good	Loam; loamy (L-CL) morainal till of limestone, granitic and shale origin.	Orthic Dark Gray
FTN	Fortina	Poor	Sandy loam; moderately to strongly calcareous sands and gravelly sands.	Rego Humic Gleysol
JAY	Jaymar	Well	Loam; coarse loamy over variable layer of sands or gravelly sands over regional loam till.	Orthic Black
LEI	Levine	Imperfect	Silty clay loam; loamy (L-CL) stratified recent fluvial deposits.	Gleyed Cumulic Regosol
LGD	Longdens	Imperfect	Sandy loam; coarse loamy over variable layer of sands or gravelly sand over regional loam till.	Gleyed Eluviated Black
LRY	Leary	Well	Loamy sand; moderate to strongly calcareous, sandy to sandy skeletal beach and outwash deposits.	Orthic Dark Gray
MHC			Marsh areas	
MOW	Mowbray	Well	Silty clay loam; stratified, dominantly silt loam to silty clay loam, upper terrace.	Cumulic Regosol
MRH	Marringhurst	Well	Loamy sand; moderately to strongly calcareous sands and gravelly sands.	Calcareous Black
NDL	Newdale	Good	Loam to clay loam; loamy (L-CL), strongly calcareous morainal till of limestone, granitic and shale origin.	Orthic Black
OZA	Ozerna	Well	Sandy loam; moderate to strongly calcareous coarse loamy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till. A coarse textured layer of sand and gravel often occurs at the lithological contact.	Orthic Dark Gray
PEN	Penrith	Poor	Loam; loamy (L-CL) strongly calcareous morainal till of limestone, granitic and shale origin.	Humic Luvic Gleysol
RBN	Roblin	Poor	Loam; weak to moderately calcareous, fine loamy to clayey sediments in depressional areas of fine loamy morainal till.	Humic Luvic Gleysol
SZR	St. Lazare		Variable; variable materials along valley slopes (colluvial)	Variable
1		Well	Loam; loamy (L-CL till)	

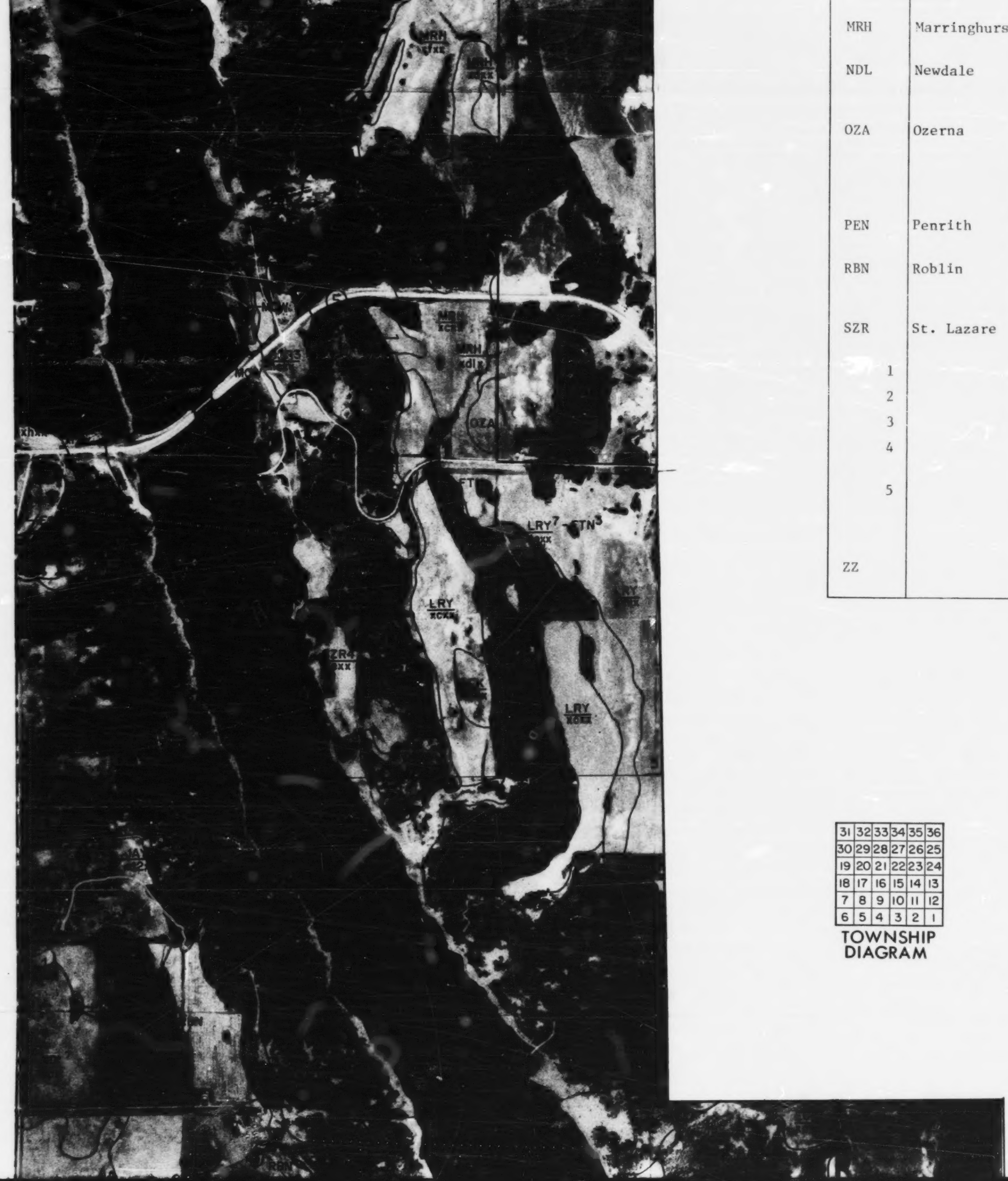
SOILS OF THE SHELLMOUTH RESERVOIR-NORTH AREA





MAP LEGEND

Soil Symbol	Soil Name	Soil Drainage	Dominant Surface Texture and Parent Material	Soil Classification Subgroup
ASB	Assiniboine	Imperfect	Silty clay; stratified recent alluvial sediments of dominantly silty clay to clay.	Gleyed Cumulic Regosol
BEO	Benton	Well	Clay; weakly calcareous, slightly saline clay from weathered shale, with ironstones.	Solonetzic Dark Gray
BKR	Basker	Poor	Silty clay loam; stratified recent alluvial sediments of sandy loam to silty clay loam.	Rego Humic Gleysol
DVD	Davidson	Well	Loamy sand; weak to moderately calcareous, coarse loamy to sandy textured lacustrine deposits.	Orthic Dark Gray
ECK	Erickson	Good	Loam; loamy (L-CL) morainal till of limestone, granitic and shale origin.	Orthic Dark Gray
FTN	Fortina	Poor	Sandy loam; moderately to strongly calcareous sands and gravelly sands.	Rego Humic Gleysol
JAY	Jaymar	Well	Loam; coarse loamy over variable layer of sands or gravelly sands over regional loam till.	Orthic Black
LEI	Levine	Imperfect	Silty clay loam; loamy (L-CL) stratified recent fluvial deposits.	Gleyed Cumulic Regosol
LGD	Longdens	Imperfect	Sandy loam; coarse loamy over variable layer of sands or gravelly sand over regional loam till.	Gleyed Eluviated Black
LRY	Leary	Well	Loamy sand; moderate to strongly calcareous, sandy to sandy skeletal beach and outwash deposits.	Orthic Dark Gray
MHC			Marsh areas	
MOW	Mowbray	Well	Silty clay loam; stratified, dominantly silt loam to silty clay loam, upper terrace.	Cumulic Regosol
MRH	Marringhurst	Well	Loamy sand; moderately to strongly calcareous sands and gravelly sands.	Calcareous Black
NDL	Newdale	Good	Loam to clay loam; loamy (L-CL), strongly calcareous morainal till of limestone, granitic and shale origin.	Orthic Black
OZA	Ozerna	Well	Sandy loam; moderate to strongly calcareous coarse loamy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till. A coarse textured layer of sand and gravel often occurs at the lithological contact.	Orthic Dark Gray
PEN	Penrith	Poor	Loam; loamy (L-CL) strongly calcareous morainal till of limestone, granitic and shale origin.	Humic Luvic Gleysol
RBN	Roblin	Poor	Loam; weak to moderately calcareous, fine loamy to clayey sediments in depressional areas of fine loamy morainal till.	Humic Luvic Gleysol
SZR	St. Lazare		Variable; variable materials along valley slopes (colluvial)	Variable
1		Well	Loam; loamy (L-CL till)	Orthic Dark Gray

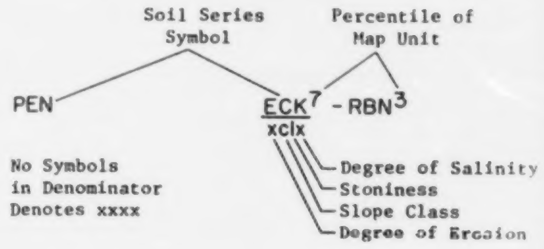

MRH
MRH xdlx
MRH
OZA
LRY⁷ - ETN³
LRY xcxx
SZR4 xxx
LRY xcxx

			to silty clay loam, upper terrace.	
MRH	Marringhurst	Well	Loamy sand; moderately to strongly calcareous sands and gravelly sands.	Calcareous Black
NDL	Newdale	Good	Loam to clay loam; loamy (L-CL), strongly calcareous morainal till of limestone, granitic and shale origin.	Orthic Black
OZA	Ozerna	Well	Sandy loam; moderate to strongly calcareous coarse loamy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till. A coarse textured layer of sand and gravel often occurs at the lithological contact.	Orthic Dark Gray
PEN	Penrith	Poor	Loam; loamy (L-CL) strongly calcareous morainal till of limestone, granitic and shale origin.	Humic Luvic Gleysol
RBN	Roblin	Poor	Loam; weak to moderately calcareous, fine loamy to clayey sediments in depressional areas of fine loamy morainal till.	Humic Luvic Gleysol
SZR	St. Lazare		Variable; variable materials along valley slopes (colluvial)	Variable
1		Well	Loam; loamy (L-CL till)	Orthic Dark Gray
2		Well	Loamy sand; dominantly sands and gravelly sands	Calcareous Black
3		Well	Clay; dominantly clay from weathered shale.	Solonetzic Dark Gray
4		Well	Variable; mixed materials, clay, loam (till), sand, gravel	Orthic Dark Gray (Solonetzic Dark Gray)
5		Poor	Mesic peat, thin moderately decomposed organic deposits derived from fen type vegetation overlying undifferentiated materials of gravelly sand to clay.	Terric Mesisol or Rego Humic Gleysol
ZZ			Water	

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

TOWNSHIP DIAGRAM

MAP UNIT SYMBOLOGY


Soil Series Symbol
Percentile of Map Unit
PEN
ECK⁷ - RBN³
xclx
No Symbols in Denominator Denotes xxxx
Degree of Salinity
Stoniness
Slope Class
Degree of Erosion

Degree of Erosion

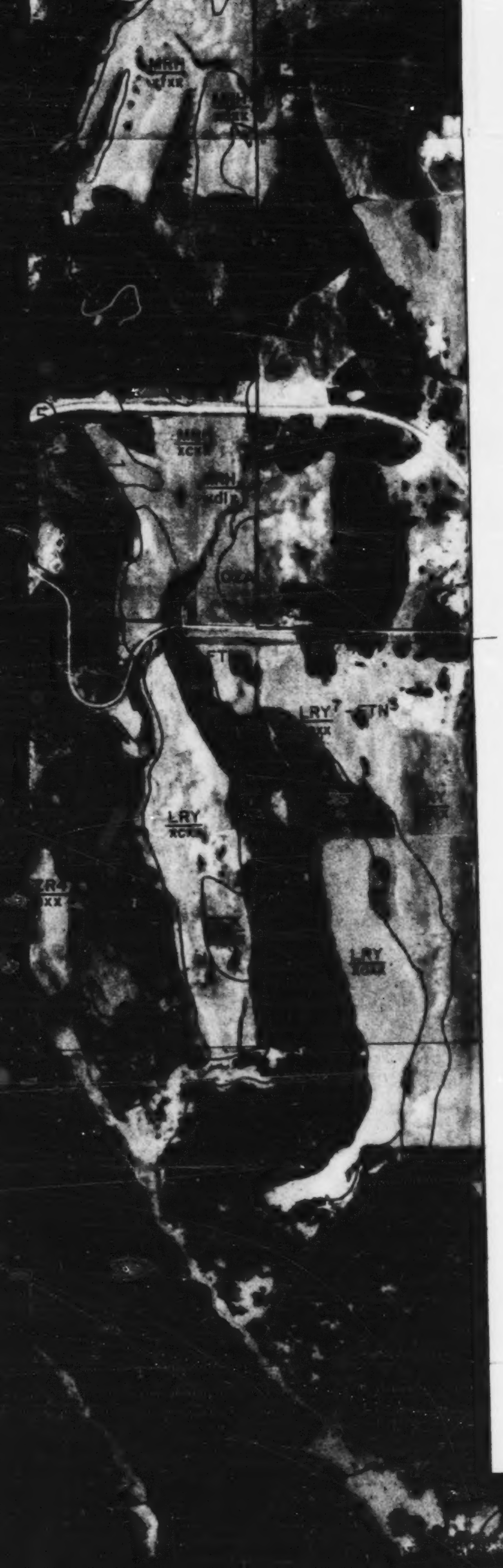
x	minimal soil loss
1	slightly eroded
2	moderately eroded

Slope Class

x	0-2%	level to nearly level
c	2-5%	very gentle slopes
d	5-9%	gentle slopes
e	9-15%	moderate slopes
f	15-30%	strong slopes
g	30-45%	very strong slopes
h	45-70%	extreme slopes

Stoniness

x	non-stony
1	slightly stony
2	moderately stony
3	very atony
4	exceedingly stony
5	excessively stony

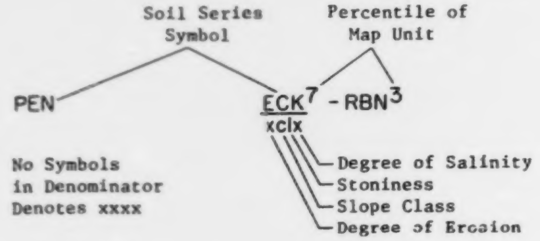


			to silty clay loam, upper terrace.	
MRH	Marringhurst	Well	Loamy sand; moderately to strongly calcareous sands and gravelly sands.	Calcareous Black
NDL	Newdale	Good	Loam to clay loam; loamy (L-CL), strongly calcareous morainal till of limestone, granitic and shale origin.	Orthic Black
OZA	Ozerna	Well	Sandy loam; moderate to strongly calcareous coarse loamy lacustrine deposits overlying moderately to strongly calcareous, fine loamy morainal till. A coarse textured layer of sand and gravel often occurs at the lithological contact.	Orthic Dark Gray
PEN	Penrith	Poor	Loam; loamy (L-CL) strongly calcareous morainal till of limestone, granitic and shale origin.	Humic Luvic Gleysol
RBN	Roblin	Poor	Loam; weak to moderately calcareous, fine loamy to clayey sediments in depressional areas of fine loamy morainal till.	Humic Luvic Gleysol
SZR	St. Lazare		Variable; variable materials along valley slopes (colluvial)	Variable
1		Well	Loam; loamy (L-CL till)	Orthic Dark Gray
2		Well	Loamy sand; dominantly sands and gravelly sands	Calcareous Black
3		Well	Clay; dominantly clay from weathered shale.	Solonetzic Dark Gray
4		Well	Variable; mixed materials, clay, loam (till), sand, gravel	Orthic Dark Gray (Solonetzic Dark Gray)
5		Poor	Mesic peat, thin moderately decomposed organic deposits derived from fen type vegetation overlying undifferentiated materials of gravelly sand to clay.	Terric Mesisol or Rego Humic Gleysol
ZZ			Water	

31	32	33	34	35	36
30	29	28	27	26	25
19	20	21	22	23	24
18	17	16	15	14	13
7	8	9	10	11	12
6	5	4	3	2	1

TOWNSHIP
DIAGRAM

MAP UNIT SYMBOLOGY



Degree of Erosion

x minimal soil loss
1 slightly eroded
2 moderately eroded

Slope Class

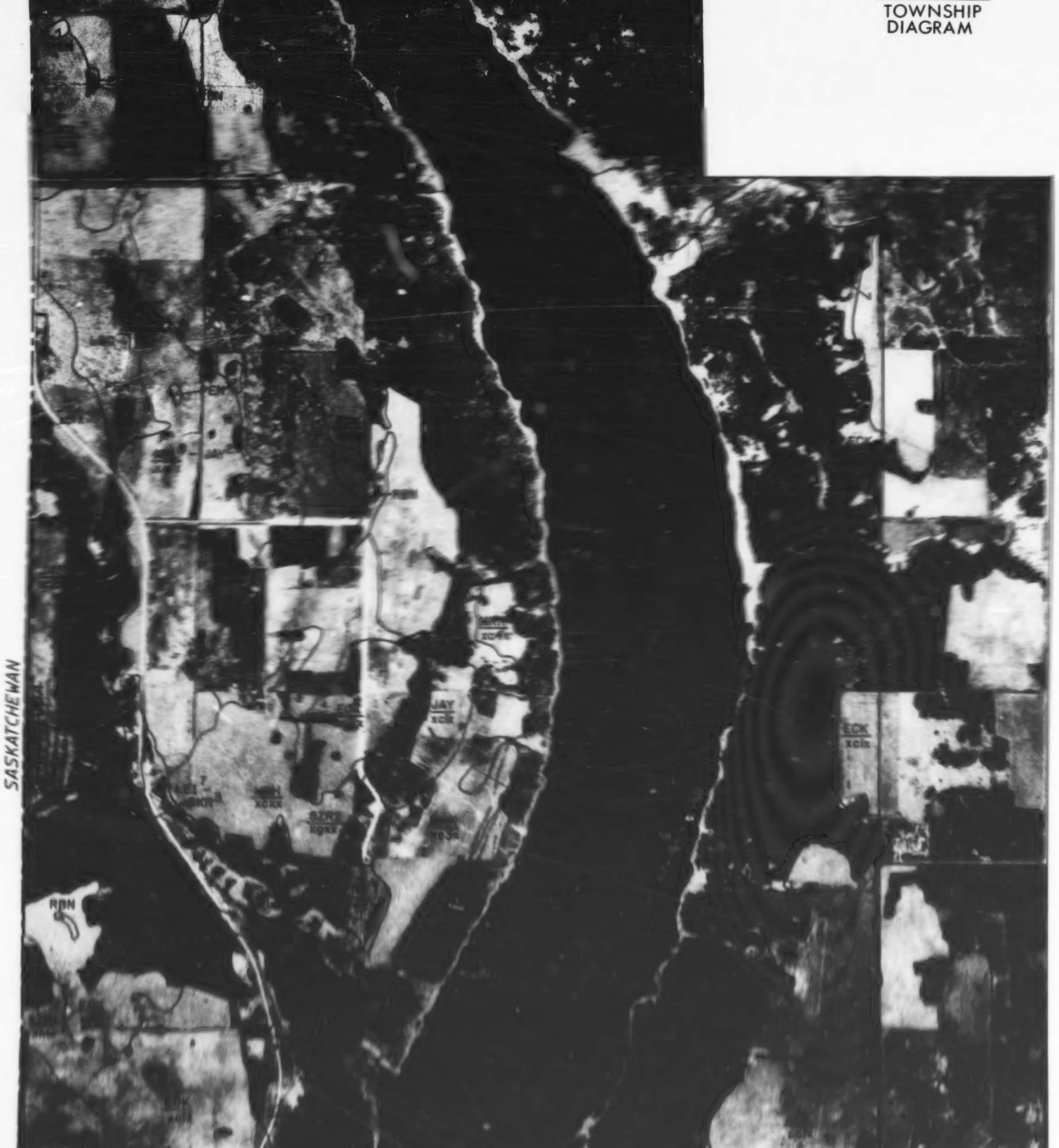
x	0-2%	level to nearly level
c	2-5%	very gentle slopes
d	5-9%	gentle slopes
e	9-15%	moderate slopes
f	15-30%	strong slopes
g	30-45%	very strong slopes
h	45-70%	extreme slopes

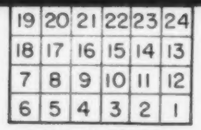
Stoniness

x non-stony
1 slightly stony
2 moderately stony
3 very stony
4 exceedingly stony
5 excessively stony

Degree of Salinity

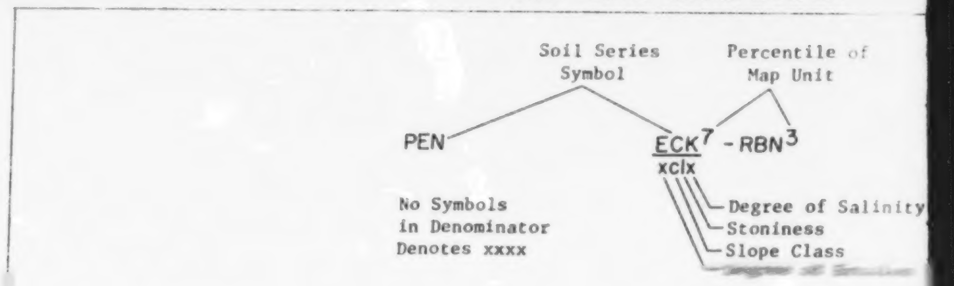
x	non to very weakly	(0-4 mS/cm)
s	weakly saline	(4-8 mS/cm)
t	moderately saline	(8-15 mS/cm)
u	strongly saline	(>15 mS/cm)


SASKATCHEWAN
PEN
ECK
xclx
JAY
xclx
RBN
TP. 25


19 20 21 22 23 24
18 17 16 15 14 13
7 8 9 10 11 12
6 5 4 3 2 1

TOWNSHIP DIAGRAM

MAP UNIT SYMBOLOGY


Soil Series Symbol
Percentile of Map Unit
PEN
ECK⁷ - RBN³
xclx
No Symbols in Denominator Denotes xxxx
Degree of Salinity
Stoniness
Slope Class
Degree of Erosion

Degree of Erosion

- x minimal soil loss
- 1 slightly eroded
- 2 moderately eroded

Slope Class

a	0-2%	level to nearly level
c	2-5%	very gentle slopes
d	5-9%	gentle slopes
e	9-15%	moderate slopes
f	15-30%	strong slopes
g	30-45%	very strong slopes
h	45-70%	extreme slopes
i	70-100%	steep slopes

Stoniness

- x non-stony
- 1 slightly stony
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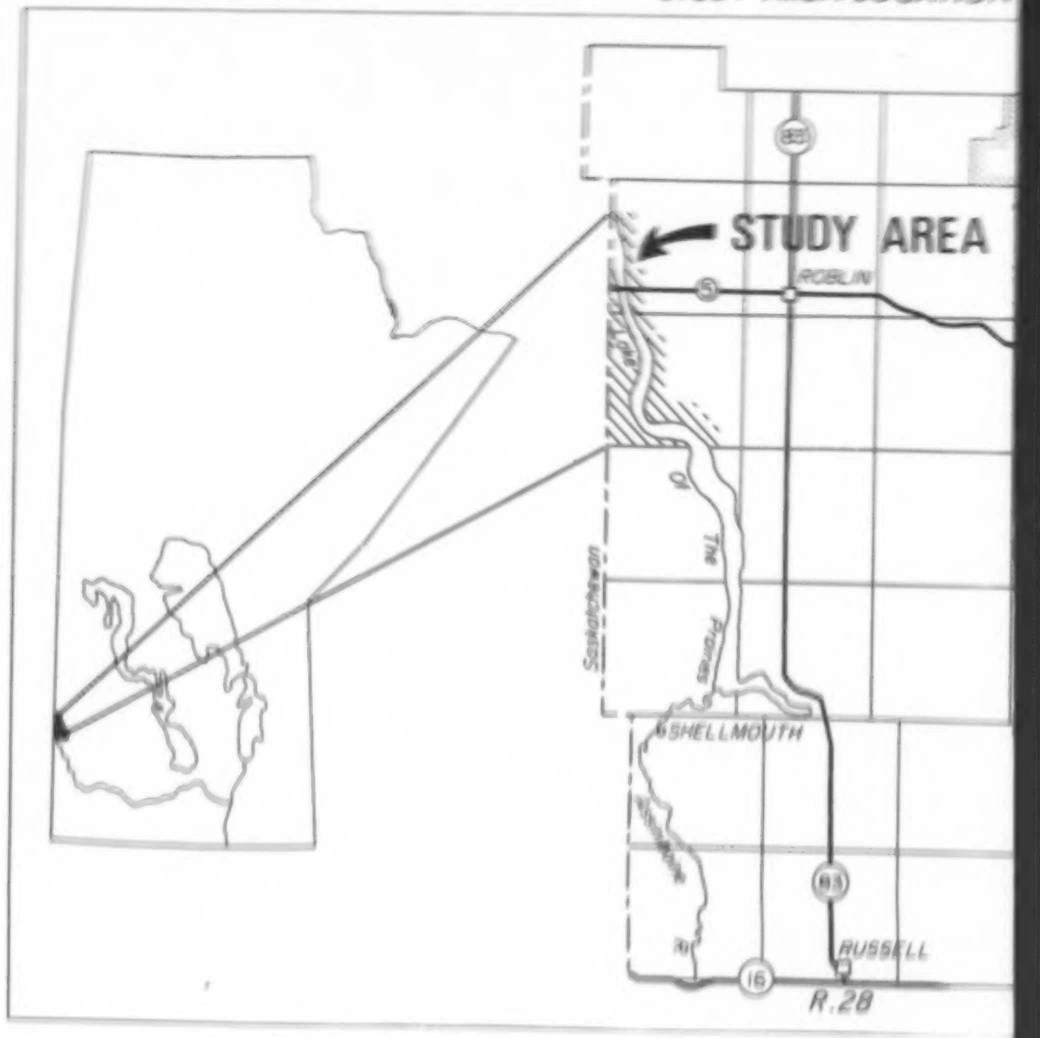
- 3 very stony
- 4 exceedingly stony
- 5 excessively stony

STUDY AREA LOCATION


STUDY AREA
ROBLIN
83
5
Saskatchewan
Of The Prairies
SHELLMOUTH
Assiniboine
83
16
RUSSELL
R.28

TOWNSHIP DIAGRAM

ECK
ECK
xclx
TP.25

PEN

$\frac{ECK^{7} - RBN^{3}}{xclx}$

No Symbols
in Denominator
Denotes xxxx

Degree of Salinity
Stoniness
Slope Class
Degree of Erosion

Degree of Erosion

x minimal soil loss
1 slightly eroded
2 moderately eroded

Slope Class

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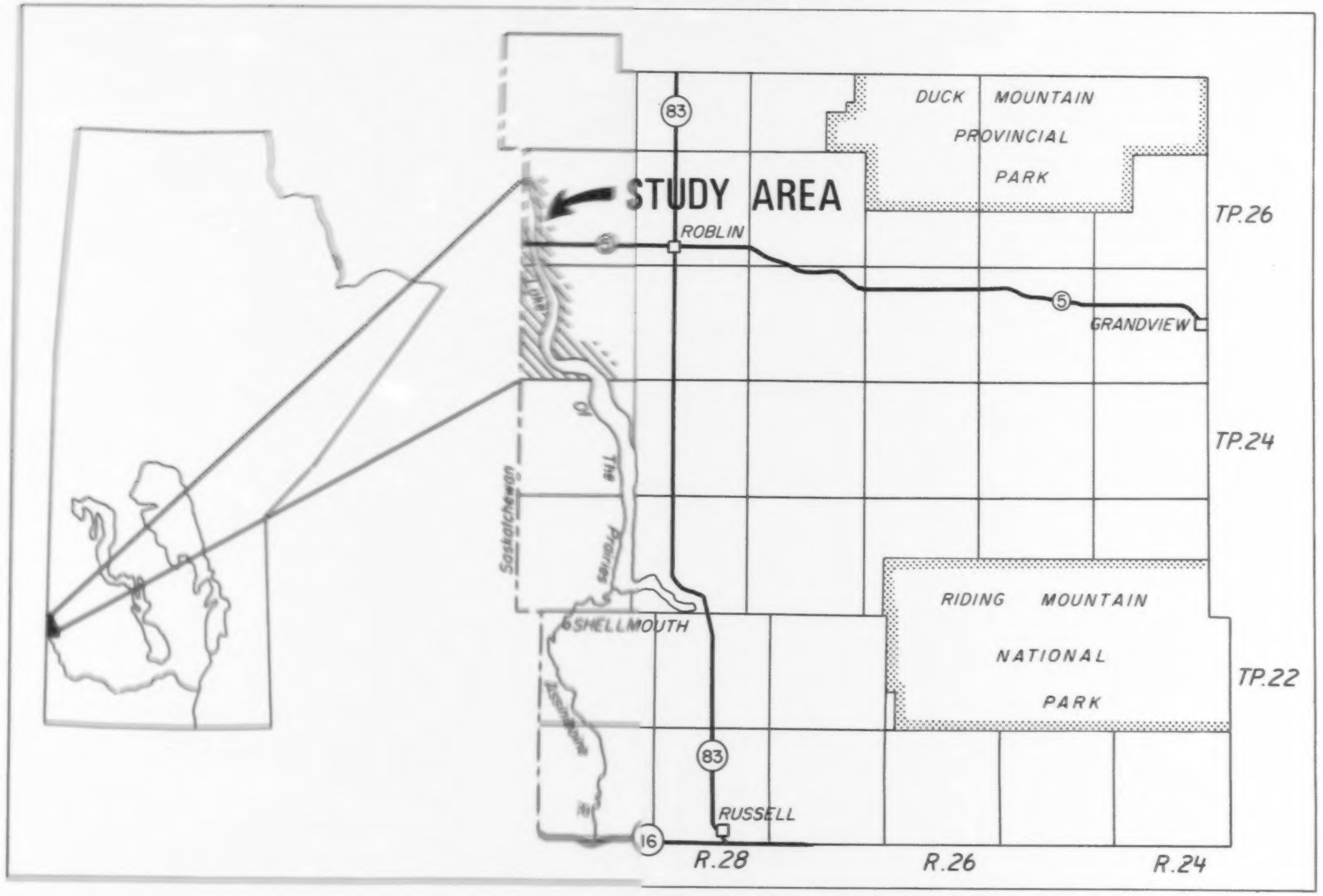
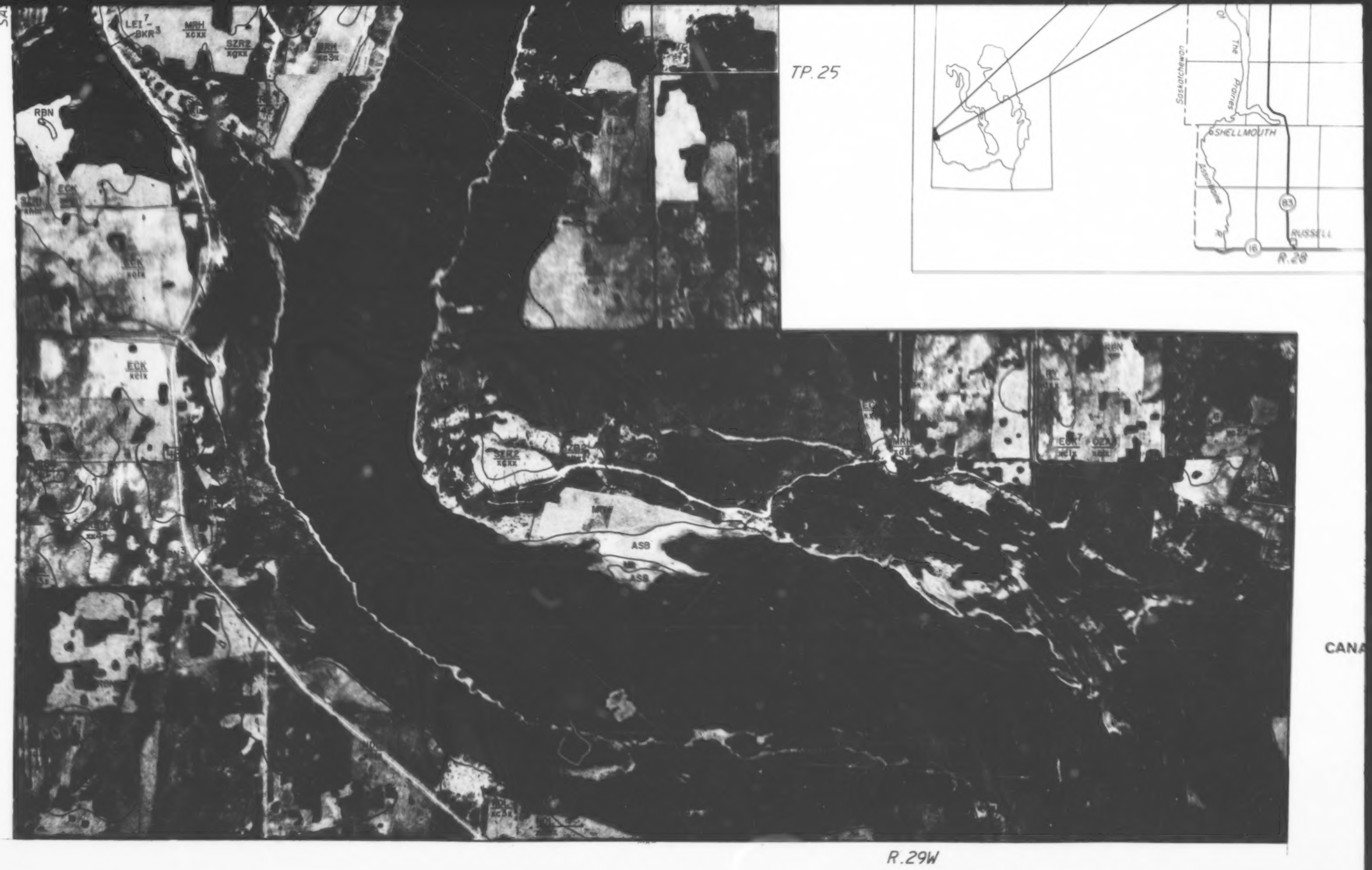
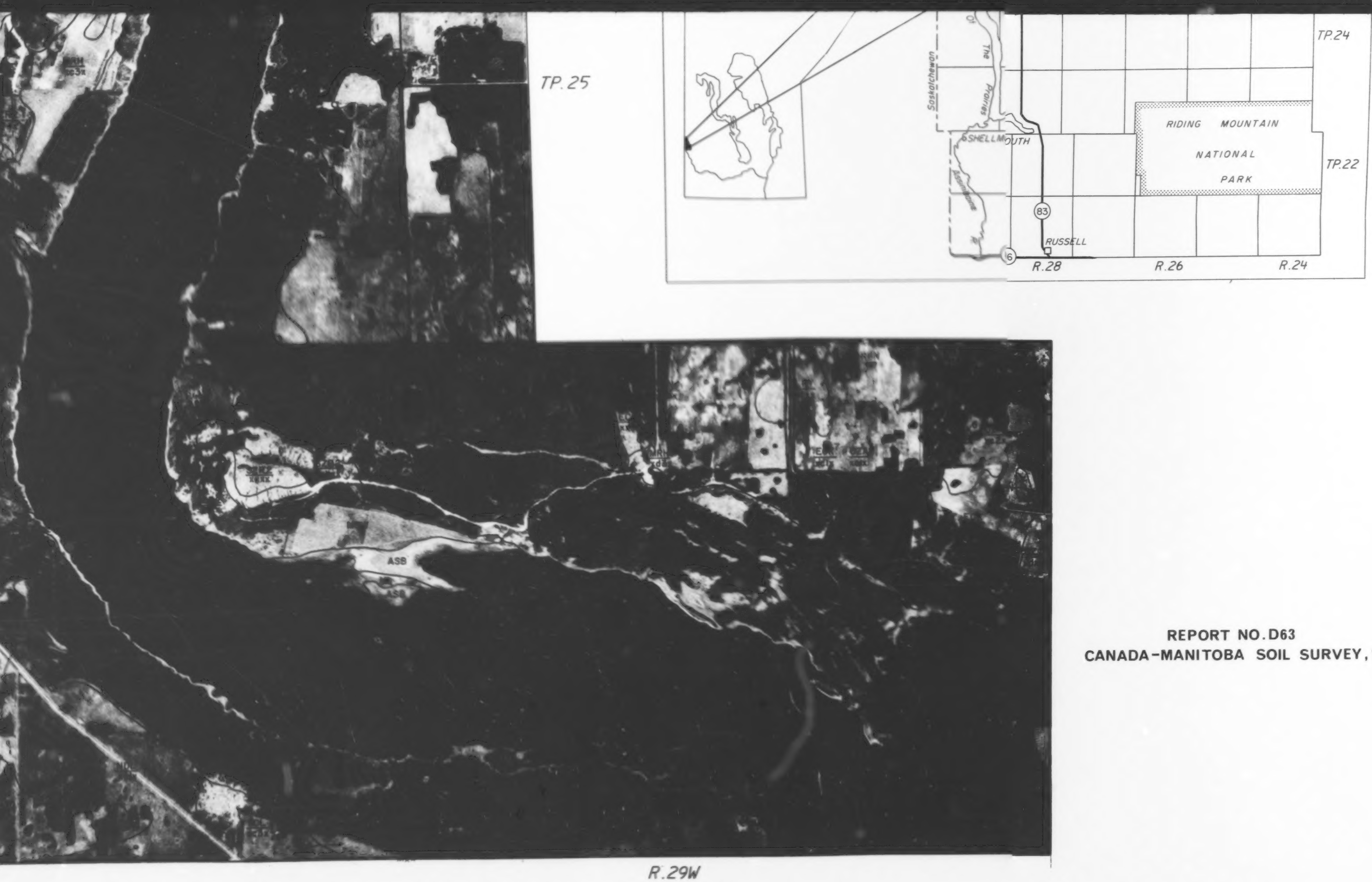
STUDY AREA LOCATION


DUCK MOUNTAIN PROVINCIAL PARK
83
STUDY AREA
ROBLIN
5
TP.26
GRANDVIEW
TP.24
Saskatchewan
Of The Prairies
RIDING MOUNTAIN NATIONAL PARK
SHELLMOUTH
TP.22
Assiniboine
83
RUSSELL
16
R.28
R.26
R.24


SA
LEI7 - BKR3
MRH
xcxx
SZR2
xgxx
MRH
xc3x
RBN
ECK
SZR1
ECK
xc1x
ECK
xc1x
OZA
TP. 25
Saskatchewan
Of
The
Prairies
SHELLMOUTH
Assiniboine
83
16
RUSSELL
R. 28
SZR2
xgxx
MRW
ASB
ASB
MRH
RBN
ECK7
xc1x
OZA
CANA
R. 29W


TP. 25
TP.24
TP.22
RIDING MOUNTAIN NATIONAL PARK
Saskatchewan
Of The Prairies
SHELLMOUTH
Assiniboine
83
16
RUSSELL
R.28
R.26
R.24
ASB
ASB
R.29W

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CANADA-MANITOBA SOIL SURVEY, 1987